CIL 2048
USER MANUAL

C49918-020-001-01
Revision 1

Revisions History

Revision 1	- minor page-setting improvements

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1 Overview

Today artificial vision applications are increasing in industrial process.

However a " classical " vision solution requires a hardware configuration including a PC, acquisition and processing boards,... and a programmer to develop specific software for even the simplest of tasks.

For this reason LORD Ingénierie has developed a parametrizable vision system that integrates, in a few cm3, the functions of both a line scan camera and a computer.

The **CIL 2048** is a high-performance compact vision system, parametrizable in a few clicks that will autonomously perform for you all the classical functions of a line scan camera.

No video at output, the required information (measure or signal) is given directly.

Operational in a few minutes, the CIL can be used on all automated production lines and in numerous industrial systems using control and inspection by artificial vision.

This chapter introduces the CIL2048 and explains the organization of this manual.

Technical Support

To get any support please visit our web site http://www.lord-ing.com or send an e-mail to the LORD INGENIERIE support team at support@lord-ing.com .

If you need to return a camera for repair, please contact us first for return instructions.

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About This Manual

This manual is valid for the **version 4.1 build 1** of the CIL 2048 firmware.

If your CIL 2048 is equipped with a previous release, it can be updated for free. Please refer to the paragraph “Updating the firmware”. For more information on how to get the updater file, please contact Technical Support.

Online Version

This manual is available in an electronic format (Portable Document Format, or PDF). To obtain a hard copy of the manual, print the file using the printing capability of Adobe Acrobat*, the tool used for the online presentation of the document.

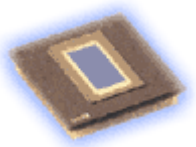
2 CIL 2048 Concepts

This chapter looks over some of the basic concepts used in the line scan processing part of CIL 2048. It also describes the elements of a vision system based on a CIL 2048.

Introduction to line scan video

The CIL 2048 is based on a **line scan CCD sensor** . This is an image acquisition device formed of a single line of photosensitive elements. Therefore, the video is acquired line by line compared to matrix sensors which generate "frames".

Line scan CCD sensor



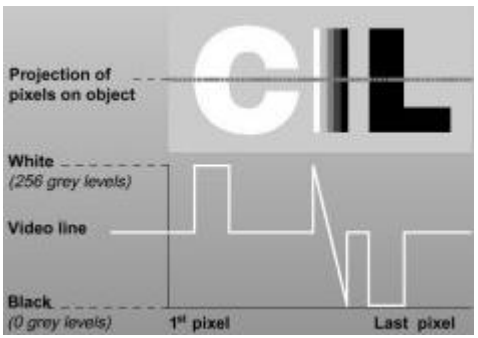
Matrix CCD sensor

Line scan cameras are very suitable for all inspection procedures for identifying non-conformities in continuous materials (glass ribbons, paper, metal, plastics, powders, etc.) as well as for a wide range of contact less measurement applications.

Line scan video signals

A line scan video line can be considered to be a "cartography" of the brightness of the points of the line observed by the camera.

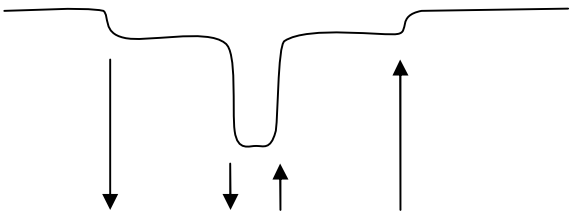
Each point's luminosity is expressed as grey levels (0 to 255 for 8 bit intensity resolution).



Concept of Transitions

An abrupt variation in the grey scale level corresponds to an edge of the object or to a variation in its tint or its aspect. The detection of this variation or "transition" will therefore

allow taking contactless measurements of very high precision thanks to the very high resolution of the line scan sensors, which is better than that of standard matrix sensors. For example, it will be possible to know for a tape viewed on a clear background its position and its width according to the location of the transitions corresponding to the edges. Similarly, if a medium of uniform tint is observed, it will be possible to instantaneously detect stains or holes in this medium (according to the way it is illuminated).

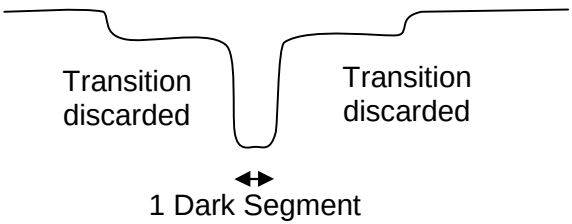


4 Transitions :
2 downwards 2 upwards

The hard-wired transition detector within the CIL 2048 detects all abrupt variations of video signal level and stores the position of these transitions in a buffer accessible to the processing software.

Concept of Segments

Most often the transitions are analyzed by pairs of opposite types. For example, rising and falling transitions corresponding to two edges of an object allow calculating its width. A pair of transitions of opposite types define a segment. A segment may be a dark type if its first transition is downward or a clear type if its first transition is upward.



Directly analyzing the transitions implicates decoding the direction of each transition: this decoding entails a time loss. However, it is possible to specify the types of segments that

are of interest and the transition processor can pair the transitions to create segments and eliminate the transitions that cannot be paired.

As a result, when the processor is working in "segment analysis" mode, some transitions may be lost. The "transition detection" mode allows these transitions to be recovered.

The CIL2048 allows two processing windows to be overlapped, one window in "locate segment analysis" mode and the other in "locate transitions" mode.

Lens

The object is viewed through a lens placed on the Nikon mounting at the camera front. The lens is interchangeable. Its focal length must be selected according to the distance from the camera to the object and the width of the field of view. The lens must be adjusted in terms of focusing (focus) and aperture (diaphragm).

Integration time

It represents the time during which the light is converted into electric charges in the CCD sensor. The greater this time, the greater the video signal level will be for a given lighting. The integration time must be adjusted according to the lighting of the object and the lens diaphragm to obtain a video signal sufficient and not saturated (that is, without being maximum at any point in the video line (255 LSB)).

Trigger

The integration of the light on the CCD, the discharge of accumulated charges, and then the processing of the video line are triggered at precise moments either by an external event or at a defined line rate. With CIL 2048, four types of triggers are possible:

- **free running trigger**: the capture of a new line starts as soon as possible. This mode provides the highest line rate.
- **internal clock trigger**: the trigger is generated by an internal clock with an adjustable period. If the internal clock runs faster than the maximum line rate, the “trigger overrun” led turns on.
- **external trigger**: one or more inputs (INP0 to INP2) can be used to trigger the cycle on rising edges, falling edges or both. If all the trigger conditions on the inputs cannot be handled because they would exceed the maximum line rate, the trigger overrun led turns on.
- **CAN bus trigger**: an external device can trigger the cycle at the same time on all cameras connected to the bus (more information can be found in the paragraph “CAN Frames definition”).

Line rate

The line rate is the number of video lines per second that the CIL 2048 can proceed. This implies for a moving object a certain distance on the object between two video lines. Therefore, the object's speed has to be taken into account according to the desired resolution in the direction of the movement.

The line rate is related to :

- The trigger period
- The integration time
- The processing time for a video line

The longest time conditions the effective line rate. The CIL 2048 adjusts the rate automatically. This means that, if the triggered line rate cannot be met, the CIL 2048 will operate at the maximum possible frequency. If this occurs, the trigger overrun LED will be lit.

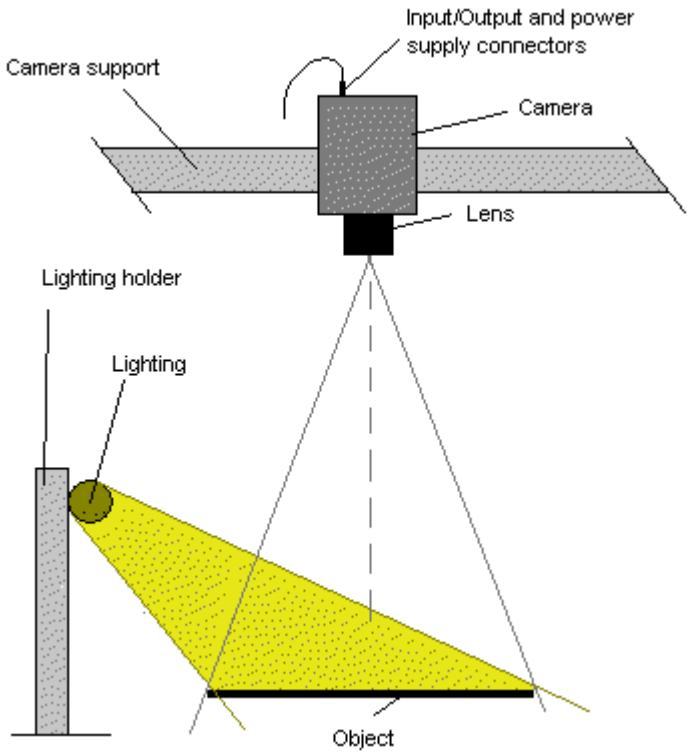
A vision system with the CIL 2048

The smart line scan camera performs not only the acquisition of the image, but also the processing of the image (averaging a parameter presetting) to assign one or several of these outputs the value of a "result" (for example, "Good" / "Bad", the value of a dimension, etc.).

A vision system based on a CIL 2048 camera consists of the following elements:

- A camera, which allows displaying the object, and processing the "image" information to deduct a "result".
- A lighting, which allows highlighting the object to be displayed.
- A lens, which allows imaging the object on the camera's sensor.
- Mechanical supports, which are adapted for the lighting and the camera.
- Outputs connections to transmit the result

The development kit including a video monitor is used during the parameterisation of the camera and the tests of the vision application.



Physical installation of the CIL camera

CAUTION: The different grounds are connected inside the camera, and are connected to its metal case. In order to avoid any ground loop being able to induce spurious electromagnetic signals, it is highly recommended to isolate the camera from the metal mass on which it is possibly assembled.

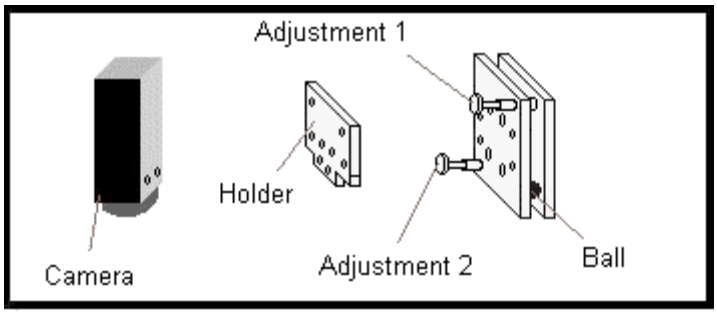
Using the TTP adjustment system

LORD Ingénierie provides an angular adjustment system (reference "TPP ") to ease the adjustments of the camera and isolate the camera case from the metal mass.

Mounting the CIL 2048 on a TPP

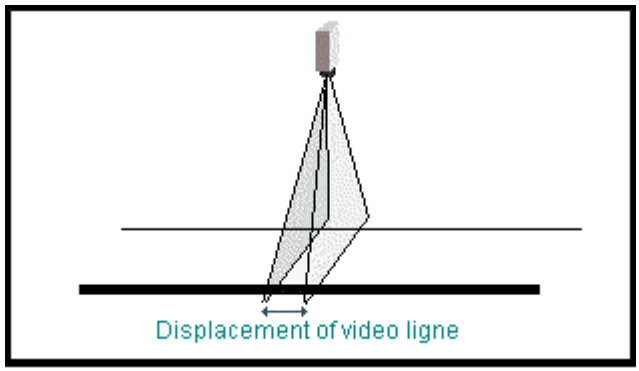
1. Mount the support on one of the sides of the camera by using four M4 screws (caution: make sure the sensor line is oriented correctly).

2. Mount the angular adjustment system on the gantry by using four M6 screws.
3. Then mount the support and the camera on the angular adjustment system by using the four screws supplied.

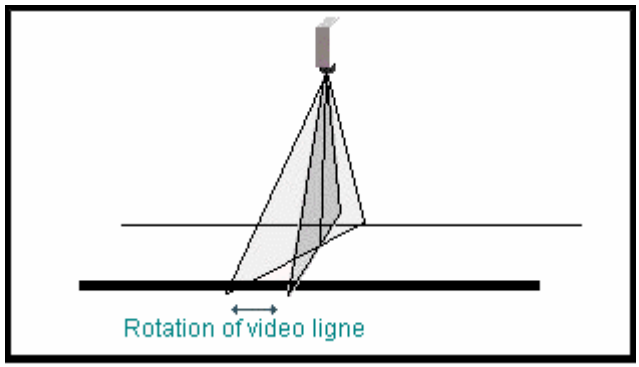


TPP adjustments

Adjustment 1 allows moving the video line.

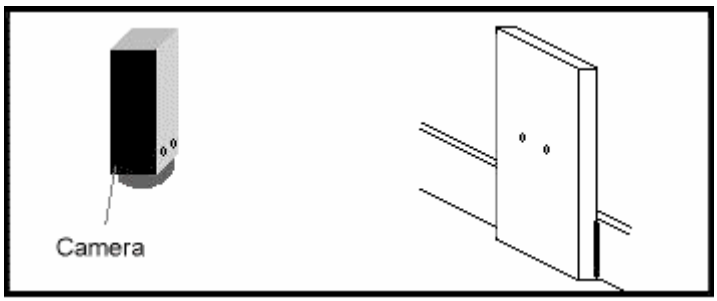


Adjustment 2 allows orienting the video line.



Mounting the CIL 2048 on a gantry without angular adjustment

Mount the camera on a plate welded to a gantry (caution: make sure the sensor line is oriented correctly).



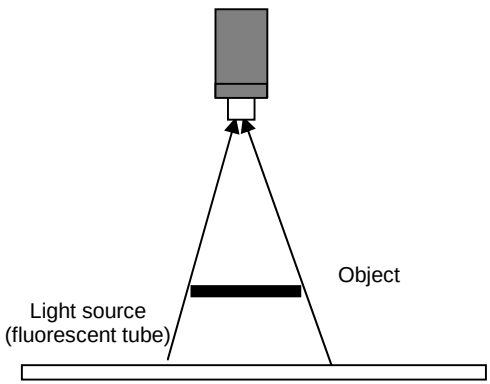
Lighting

Lighting strategy

There are two ways to light an object :

- From beneath (transmitted light)
- From top (light reflected or diffused on the object)

Transmitted light

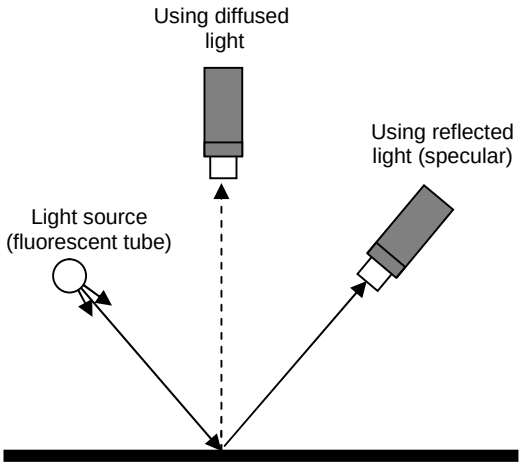


A lighting from beneath is mainly used to perform applications such as:

- width measurement
- position checking
- hole detection

If the object is transparent, this lighting can achieve detection of stains on glass, etc.

Light reflected or diffused on the object



With top lighting, the camera can be placed at different angles.

At the reflection angle (specular reflect), it will be able to make appear surface defects in black on a white background. This lighting is especially useful for detecting surface defects on metallic surfaces.

At a different angle, the camera will receive the light diffused by the surface. This is more suitable for detecting spots on a diffusing surface.

The different types of sources

Several types of lighting sources exist. They are more or less powerful, directive, with different colours. The following sources can be indicated:

Fluorescent tubes ("Neons")

They are often used to observe large areas.

Halogen lamps

Halogen lamps are more powerful and more directive. They are often used when small areas are to be observed, or when we work with reflected lighting and the object reflects very little light.

How to light the object

Generally, we try to obtain lighting on the object which is as uniform as possible. All this is done to avoid obtaining a saturated signal in a part of the video line and a weak signal in another part. Here are a few lighting methods:

For example:

- To take a width measurement, a fluorescent tube in transmitted lighting is used to detect the object's edges.

- To detect an object on a dark tape, halogen lamps in reflected lighting are used under grazing incidence in order to be capable of observing the object's edges.

Caution : To prevent video signal beating phenomena, a DC power supply (halogen source) has to be used or a 24V high frequency electronic ballast (fluorescent tube).

Lens

Lens selection

For the choice of lens, two cases are to be distinguished:

- one case is when the lens is at a fixed well-known distance from the camera
- the other case is when the distance between the camera and the object can vary.

Object at a fixed well-known distance

Data:

- W=the width to be observed in mm
- D=distance between the camera and the object in mm.

Calculation of the focal length F (mm):

$$F = \frac{D * 28.672}{W + 28.672}$$

Select the lens with the closest focal length F'.

Calculate the final distance D' to place the camera:

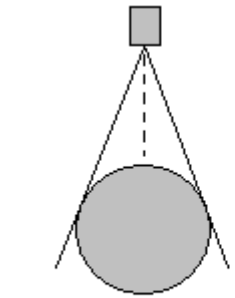
$$D' = \frac{F' * (W + 28.672)}{28.672}$$

Object at fluctuant distance

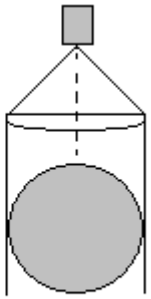
In the case where the distance between the camera and the object varies, the measurement can be erroneous. In fact, if the object is moved closer to the camera, the object will be "seen" with a larger size.

In addition, if the object's edges are not vertical (like for the measurement of a diameter), then the measurement will also be erroneous.

To alleviate these measurement errors, a telecentric lens has to be used which is specific for each application.



Measurement with a usual lens



Measurement with a telecentric lens

For the telecentric lens adapted to your needs, contact Technical support

Lens adjustment

There are two lens adjustments:

- a ring which allows to adjust the focus of the lens
- a ring which allows to adjust the lens aperture to let enter more or less light

Development kit

During the parameterisation, the user uses the video monitor and mouse (configuration kit) to align the camera, adjust the focus, set the integration time and adjust the detection parameters. The unit constitutes the "configuration kit".

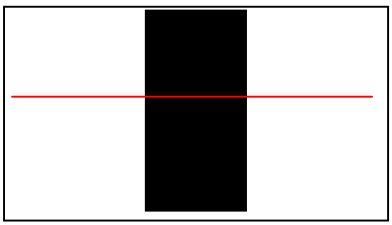
The configuration kit can be removed at any time once the system has been set up. A single configuration kit can, therefore, be used to set up several CIL systems on a production line. It can also be left in place if the user wishes to retain visual control using the scrolling image

A power supply must be connected to the CAN connector of the camera before the configuration kit can be disconnected. Pin 9 should be powered at 24V and pin 6 grounded. If a power supply is connected, the monitor can be connected and disconnected without stopping the camera.

3 Quick start

This chapter gives hints for a quick setup of a CIL 2048 application : the measurement and the control of the width of a dark object.

The simpliest way to test the camera is to make a test pattern on a paper sheet. The test pattern should be a black rectangle.



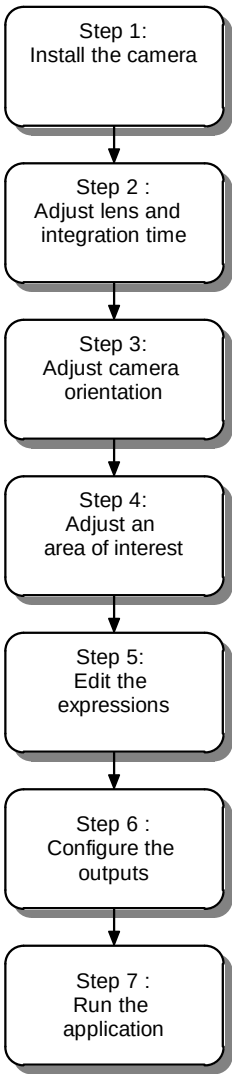
Camera Field of view

This pattern can easily be drawn using a drawing program such as MS-Paint and printed. Post the pattern on a wall and place the camera in front of the sheet on a table for example.

For better understanding, calibration has been voluntarily not used. Of course, a real application would require calibration. More information about calibration can be found in the paragraph “Calibration” .

This example will activate the output “FAULT” when there is no object in front of the camera, and the output OUT0 will be activated when the width is correct.

The CIL 2048 setup is done in seven simple steps.



Step No. 1: Install the camera

1. Remove the protective cap on the camera front.
2. Remove the cover from the lens rear.

3. Mount the lens on the camera (to do this, set the lens marker (red dot or white line) opposite the camera marker (black dot) or the extension ring (red dot) and then turn counter clockwise).
4. Remove the cover from the lens front.
5. Turn on the lighting.
6. Connect the cable "CBL/CIL/XXX" between the monitor ("camera" connector) and the camera ("display" connector).
7. Connect the mouse to the monitor ("mouse" connector).
8. Connect the monitor to an AC power outlet.
9. Make sure all the connector screws are tightened correctly.
10. Turn on the monitor (button on the monitor's rear panel). After a short delay, the main screen will be displayed. If the mouse is not connected, an error message is displayed, inviting to connect a mouse. This can be done without restarting the CIL 2048 camera.
11. Turn the switch (monitor's front panel) to enter the programming mode "PROG".
12. Click on to change the parameters, and then click on "Language" and "English".

Step No. 2: Adjust lens aperture and integration time

This step 2 consists of obtaining neither too much light nor too little light is on the camera.

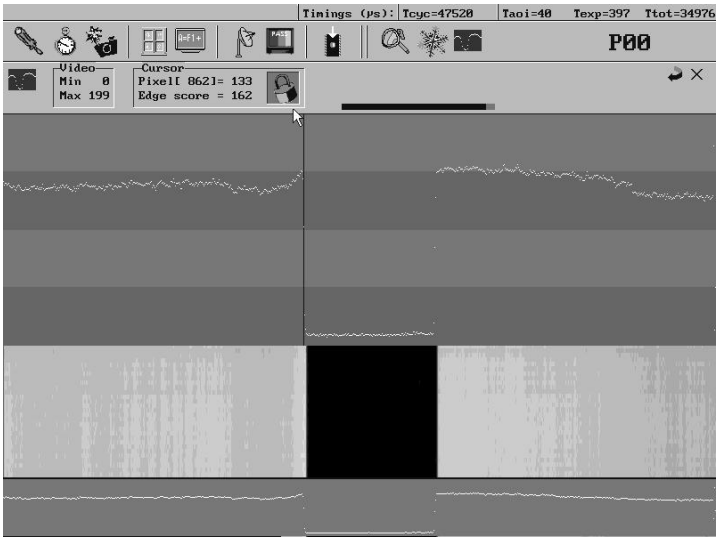
1. Click on to obtain the time management window.
2. Click on "Configuration".
3. Click on "Free Run".
4. Click on "Integration Time".
5. Adjust the integration time value to the minimum value by using the upper slider. Click on the black cursor and hold down the left button of the mouse while dragging it to the leftmost position.

6. If possible, adjust the diaphragm to obtain a video signal which is located in the upper quarter of the oscilloscope area for the white regions of the object.
7. If this not possible, set the lens at its maximum aperture and adjust the integration time to get a correct video signal.

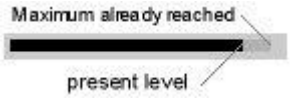
Step No. 3: Adjust the camera orientation

In this step, the camera's orientation is adjusted and the lens is focused.

1. Preset the focus ring to the distance between the camera and the object.
2. Click on to obtain the oscilloscope mode.



3. Adjust the camera's orientation to find the lighting (with an angular adjustment system, use the adjusting screw 1).
4. Readjust the camera to obtain the most uniform and whitest possible video signal (with an angular adjustment system, use the adjusting screw 2 and then the adjusting screw 1).
5. Move the cursor on one of the edges by dragging it with the mouse.
6. Click on to lock the cursor on the edge. A bar graph appears nearby.
7. Turn the lens focus ring until the bar graph is at the maximum position.



8. If necessary, adjust the integration time to have the whitest possible level (but without being saturated, that is, without being at maximum on any point in the

video line). Click on to obtain the integration time management window and then on "Integration Time"

Step No. 4: Adjust an area of interest

In this step, the area of interest and their transition detection modes for the measurements will be made are defined.

1. Click on to get the area of interest editor.
2. Click on "Configuration".
3. Click on the button near “Dark Segments” in the AOI n°1 frame. Click on the central button “Normal detection” of the frame “Edge detection”.
4. Click on the “AOI n°1” tab to open it.
5. Define the area position(take the right and left edges of the area “curtain” with the mouse cursor and adjust the area to be detected inside the curtain aperture).
6. In the frame “Selection”, click on the button for “Largest dark segment”.
7. In the frame “Sensitivity”, set the value 20 by dragging the cursor.
8. In “F computation”, select “Width”. In “G computation”, select “0”.
9. Check the selected segment by clicking “S” in “drawing”. It is drawn between the lower oscilloscope and the scrolling image. Check that VAL is 1 and note the value of F, for example, 370.

Step No. 5: Edit the expressions

This step consists of inserting a program to run the desired application.

1. Click on

to obtain the expression editor.

2. Enter the following formulas (c.f. paragraph “Enter a formula”).

```
V1 | NOT VAL1
V2 | =F1
V3 | (CHECK[F1;370;37]) AND VAL1
```

V1 is true if there is no segment in the camera’s field, V2 contains the width, and V3 is true if the width is no more than 10% different of the standard width.

Step No. 6: Configure the outputs

This step allows you to configure the CIL camera outputs : a value can be displayed on the CIL monitor, a digital output can be activated.

1. Click on

to obtain the display editor.
2. For DISP0, select V3 with the up and down arrows. Click on the "PASS / FAIL" button to display PASS / FAIL (PASS when the variable's value is different from 0 and FAIL when the variable's value is equal to 0)
3. For DISP1, select V2 and click on "Value" to display the width on the CIL monitor when returning to the "RUN" mode.
4. Click on to obtain the output editor.
5. Click on "Alarms" to configure the camera's alarm outputs.
6. For “FAULT”, select V1. The output “FAULT” will be true there is no segment in the camera’s field of view.
7. Click on the "Digital Outputs" to configure the camera's Digital outputs.
8. In the “DIG Configuration” tab, select “Direct” for OUT0.
9. In the “DIG output” tab, select V3 to drive OUT0, and then click on "Vx<>0" to activate the output when the value is different from 0

Step No. 7: Run the application

1. Click on to save all the parameters.
2. Turn the switch to enter the "RUN" mode.

4 CIL 2048 reference

Language selection

The desired language can be selected by clicking on the icon "Parameters" . The parameters adjustment panel is then displayed, as on the following screen copy.

If a tab other than "Language" is selected, click on "Language" to select it.

Select the desired language by clicking on the corresponding button. The currently selected button appears depressed.

Operating modes

The camera can operate in two modes explained hereunder :

- PROG mode
- RUN mode

If the monitor is not connected, the camera will always operate in RUN mode. On the other hand, when the development kit is connected, the mode is selected using a key on the monitor front panel.

PROG mode

The programming interface with the menus is run. The operations defined in the configuration menus are carried out in background, and the results are monitored according to the current menu operation, but the maximum line rate cannot be guaranteed.

RUN mode

The programming interface is not run. Only the required operations are carried out so that the maximum line rate is achieved. If connected, the monitor displays the scrolling image from the CCD, along with a RUN time panel composed of three fields in which the programmer can post information (c.f. Monitor display).

CIL 2048 Program

The CIL 2048's set of operative parameters, such as integration time, trigger, AOI positions, etc. constitutes a program. Each program can run a different processing or the same processing with different parameters. It is possible on the CIL 2048 to define fourteen different programs. Four digital entries NPROG[0-3] make it possible to activate the program with the corresponding number.

The programs share the table of the V1-V12 expressions. When a program is loaded, it "inherits" the previous values of the expressions.

The fourteen programs lies simultaneously in the read-write memory of the CIL2048 (RAM) and must be recorded manually in the permanent memory (flash memory). At start-up, the CIL 2048 recopies the whole set of programs in RAM and executes the program with the number that is set on the entries NPROG.

CAUTION: The program **n° 15** has a special function and **must not be used**. Indeed this program makes it possible to reset the CIL 2048. Recording the program n°15 erases all the other programs and the resets the factory configuration.

Area of interest

Definition

An area of interest – “AOI” - is defined as a window within the video line, that is a set of contiguous pixels within which segments or transitions can be identified and for which one or more numerical results can be defined.

The CIL 2048 can have four different AOI. The processing for each window is carried out in parallel by four processing channels in the transition processor. Each AOI can be set up independently of the others and the windows can overlap.

AOI parameters

An area of interest is defined by two parameters: the window's position and the transition detection sensitivity.

Position

The position defines the section of the video line within which the processor will identify transitions. No transitions will be detected outside this section. The left and right hand edges of the window must be defined.

Transition detection sensitivity

This parameter defines the minimum slope for an edge to be detected as a transition. The smaller the sensitivity, the smaller the variations in the video signal that will be detected and the greater the risk of a false transition.

NOTE: The transitions are detected by a gradient method which is not sensitive to light variations.

Selecting a segment

The processing within an AOI is carried out on a segment that must be previously selected. The CIL 2048 can select:

- the largest segment
- the leftmost segment
- the rightmost segment

Results

Five numerical values are defined for each window :

- a Boolean -0 or 1- **VAL** which indicates whether a segment within the AOI has been identified. If a segment could not be identified, for example there were no transitions, VAL is set to 0 and the other values remain unchanged.
- the integer **SNBR** gives the number of segments found in the AOI.
- the integer **TNBR** gives the total number of transitions found in the AOI.
- the two integers **F** and **G** can be used to return the result of a calculation on the selected segment: left-hand edge, right-hand edge, centre or width.

Expression Calculations

The various values defined by the calculation of the area of interest, as well as other system variables, can be combined in twelve expressions -**V1 to V12** - using operators.

The expressions are calculated one after the other, the V1 expression being calculated first.

Each expression is basically composed of an operator and values (operands) on which the operator applies. The number of operands depends on the operator and is comprised between no value and three values.

Contrary to the "natural" writing of a mathematical expression, it is necessary to key in the operator first, then its operands. For example **F1 + F2** will be keyed in by clicking first on "**+**", then on "**F1**" and then "**F2**". It is possible to specify several operators in the same expression. It is necessary for that to replace an operand by a basic expression surrounded by brackets. All the brackets must be written.

Empty expression

An empty expression has no formula and doesn't require any CPU time to be calculated. But it still has a value that can be used in another expression. This value may come from a previously executed program, which had a formula for this expression, from a Modbus writing, or from a C extension program.

Operands

When an expression is enabled, but still empty, it contains only the special operator **NOP**. It is then necessary to select the first operator of the expression among the following operators. After the selection of the operator, default operands are applied and it is possible to change them.

Operator	Operands	Description	Returned value
NOP		Default operator	0
ABS	ABS(a)	absolute value	|a|
+	a + b	addition	a+b
-	a – b	substraction	a-b
*****	a * b	multiplication	a*b
/	a / b	division	a/b if b !=0, else 2147483647
<	a < b	comparison : less than	1 if a<b, else 0
>	a > b	comparison : greater than	1 if a>b, else 0
<=	a <= b	comparison : less than or equal to	1 if a<=b, else 0
>=	a >= b	comparison : greater than or equal to	1 if a>=b, else 0
==	a == b	comparison : equal	1 if a==b, else 0
AND	a AND b	logical and	1 if a and b !=0, else 0
OR	a OR b	logical or	1 if a or b !=0, else 0
IF	IF [c ; a ; b]	logical test	a if c is !=0, else b

Operator	Operands	Description	Returned value
NOT	NOT a	logical not	0 if a != 0 , else 1
=	= a	assign directly a value. Is not necessary if another operator is present.	a
CHECK	CHECK[v ; n ; t]	checks v by respect to a nominal value n with a tolerance t.	1 if |v-n|<t, else 0
GOTO	GOTO [p]	program change : the program number p is executed	0
Some **special operators** modify the value of the expression in which they are placed:			
ACCU	ACCU[c ; v ; cz]	Counting operator : the value of the expression is incremented by v if c is true. It is set to zero if cz is true.	
FILTER	FILTER[v ;c]	Implements a numerical low-pass filter of order 1 in the cell, v being the variable in entry, multiplied by the coefficient C (C is expressed in for thousand). The value of the expression is (v*c + (1000-c)*ep)/1000, where ep is the previous value of the expression.	

CAUTION: ACCU or FILTER do not return a value and must not be used with other operators in the same expression. An expression which contains ACCU or FILTER and other operators, for example V3=(FILTER(V1,33)) + V2 will not take the awaited value. It is necessary to specify, for example: V3=FILTER(V1,33) then in a separate expression V4=V3+V2.

Operands

The following operands can be used. Some operands require an additional numerical parameter X.

Operand	Description	Value of x
(...)	bracket: the operand is calculated using a new operator	
Const x	constant numerical value X (displayed without the label "Const")	Any numerical value
INPx	logical variable (0 or 1) allowing to read the state of the digital input X	0 1 2
VALx	logical variable (0 or 1) representing the validity of the selection of the segment in AOI X	1 2 3 4
Fx	numerical value representing a measurement calculated in AOI X	1 2 3 4
Gx	numerical value representing a measurement calculated in AOI X	1 2 3 4
SNBRx	numerical value representing the number of segments detected in AOI X	1 2 3 4
TNBRx	numerical value representing the total number of transitions detected in AOI X	1 2 3 4
Vx	numerical value representing the value of expression X	1 2 ... 12
GREYLVLx	numerical value representing the grey level (0 to 255) of the pixel at the centre of the segment selected in AOI X	1 2 3 4
DELTAVx	numerical value representing the variation of the expression X relatively to the previous line	1 2 ... 12
TRIG	numerical value indicating which is the trigger which started the video line integration	2 for INP0 4 for INP1 8 for INP2
LCNT	Sequence number of the current line incremented by 1 at each video line	
CANx	numerical value representing the value of the CAN shared variable number X	1 2 ... 12

NOTE: DELTAVx is defined by the formula : $Vx_{previous\ line} - Vx_{current\ line}$.
Therefore DELTAVx is negative when Vx increments. If Vx is a logical value, DELTAVx is negative when Vx becomes true.

Numbers and units

The CIL 2048 basically process numbers as signed 32 bits integers (from -2 147 483 648 to 2 147 483 647). These numbers can be for example areas of interest's values as F and G, or expressions' values (there are a few other values).

These numbers have no internal units. Without calibration, the areas of interest's values are CCD's pixels number. After calibration, they are expressed in a metric unit. This unit (mm, m ,km..) can be chosen by the user and depends on the calibration data (c.f. Calibration)

Calibration

It is possible to express the values measured by the CIL 2048 (typically F and G) :

- **directly in pixel**. No conversion is carried out, the values of F and G are positive and lower than 2048.
- in **metric values** by simply indicating the width of the camera's field of view and the desired origin. This conversion is linear and does not take into account possible non linearities due to the lens. The values of F and G are expressed on signed 32 bits integers (ranging between -2147483648 and +2147483647).
- in **metric values with correction of the distortions** by a calibration. For that it is necessary to have a mechanical test pattern exhibiting "bars" distributed in the field. One indicates the metric position of the centre of each bar and the system calculates a polynomial, making it possible to correct the distortions and non linearities. The minimum number of "bars" is 3, which inevitably does not make it possible to correct the distortions perfectly. The maximum number is 15.

NOTE: The order of the calculated polynomial is 7 if it there has more than 7 bars, if not it is the number of bars minus 1.

The calibration uses a lookup table which is calculated once for all at start-up, and thus does not induce any loss of performance on the processing times.

Assignment of outputs

The various outputs from the CIL 2048, digital, analogical, as well as display on the monitor, must be activated, parameterized and linked to a expression. The outputs are updated at every video line, after complete calculation of the table of expressions, according to their parameters and to the value of the linked expression.

Digital outputs

The CIL 2048 has four digital outputs.

Each output can be linked to the value of any expression.

Direct control

The four outputs can be directly controlled by the value of the expression. One can specify if the output must be active when the value of the expression is true (i.e. non null) or false (i.e. null).

Temporisation

With direct control, if the value of the expression which controls the output is true only during a video line, the output will produce an impulse of the cycle duration, which can be a weak duration (a few hundreds of microseconds). This case can occur for example in the presence of a defect with a very small length. It is then possible that the device to which the CIL 2048 is connected cannot detect a so small impulse.

In order to lengthen such an impulse, the first three outputs can be time-lengthened. The temporization, expressed in milliseconds, can be adjusted between 1 and 65 ms. In this configuration, the output is activated when the value of the expression become true, but it is reset only after the end of the temporization, even if the value of the expression changes before.

Alarm outputs

The CIL 2048 has two dedicated outputs, called "FAULT" and "DATAVALID", which make it possible to validate the processing of the video line and the value transmitted by another output, the analogical output for example.

As any output, these two outputs can be linked to the value of any expression.

However, **ALARM** and **DATAVALID** have a particularity over the "normal" outputs : if the internal test program of the CIL detects a malfunction of the CIL hardware or software, ALARM will be set and DATAVALID reset, whatever the value of the control expression.

Analog output

The current analogical output makes it possible to transmit a numerical data.

The digital-to-analog converter has a resolution of 13 bits on the range 0-20mA. There is 8192 steps of approximately 2.5 µA.

It is possible to specify if one wants to work in the 0 - 20 mA range or in the 4 - 20 mA range . In this last case, the full resolution of the converter is not used; there are 6554 steps.

The analog output can be linked to the value of any expression. It is possible to specify a scaling factor, i.e. the numerical value of the expression for which the converter will give the minimal value of the output range (0 or 4 mA) and the value for which one will obtain the maximum value of 20mA.

Monitor display

One can display up to three information on the monitor screen of the CIL 2048 in RUN mode.

Each displayed information can be linked to the value of any expression.

It is possible to specify if one wishes to display the value in numerical form or a message "**PASS**" or "**FAIL**" according to the logical value of the expression (if the expression is null, FAIL will be displayed, PASS if not).

Monitor alternatives

The monitor of the development kit is a rugged and handy device for powering and programming the CIL 2048. However, for special applications, it can be replaced by other displays.

CILBOX

The CILBOX contains a power supply and provides the same connectors and interfaces than the standard monitor, and provides the same programming utilities. It must be used with an external standard SVGA monitor, or a video projector.

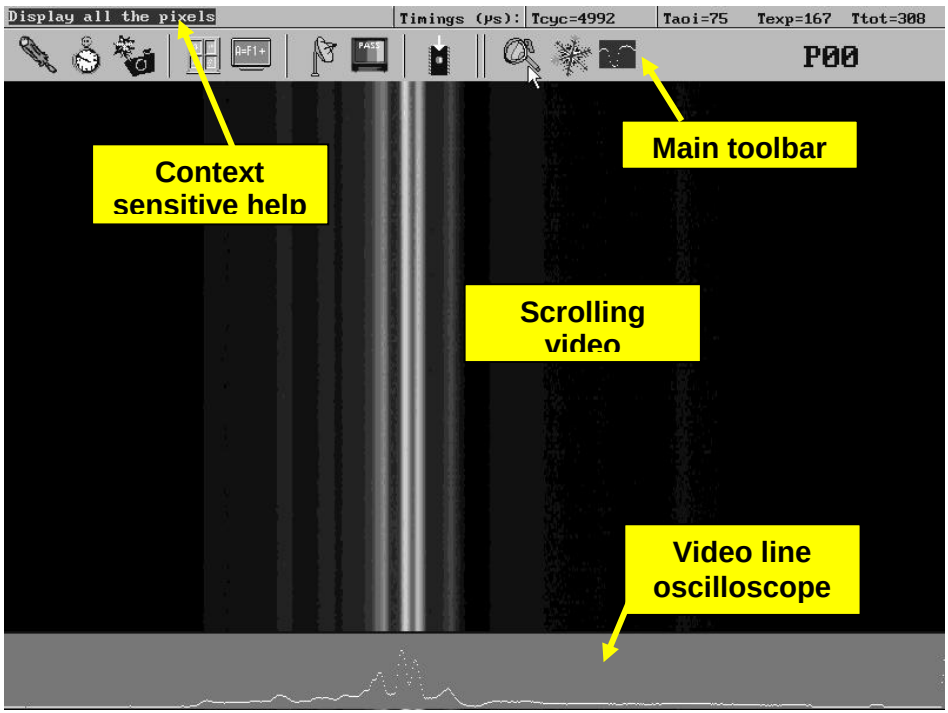
Direct connection

When the CIL 2048 display in RUN mode is relevant , the SVGA signal from the CIL2048 can be used with special devices such as VGA extender, frame grabbers, etc.

The wiring of the CIL 2048 “Monitor” connector is given in the paragraph “Monitor connector”. One must make a special cable between this connector and the device and provide programming resources if necessary (key, mouse).

5 Configuration program

Main screen



The main CIL 2048 configuration screen is laid out around the scrolling video image from the CCD. This image scrolls upwards, the most recent video line is at the bottom.

An "oscilloscope" trace of the video signal is shown at the bottom of the screen. Each pixel is represented by a point whose height is proportional to the signal level. This trace always shows the whole length of the video line from the CCD. As the monitor resolution is not high enough, the video signal is sampled in order to display the whole length of the 2048 CCD pixels in the 800 screen points.

The main toolbar and the context sensitive help are at the top of the screen. The context sensitive help shows a Tool Tip for each item pointed to using the mouse.

Information on the timings is summarized at the right top of the screen, in microseconds:

- **Tcyc** indicates the effective cycle time. This value is displayed on black background if the real cycle time is higher than the desired cycle time (internal trigger).
- **Taoi** indicates the time spent to calculate information of the four area of interest.
- **Texp** indicates the time spent to calculate the expression table.
- **Ttot** indicates the total time for the processing of a video line, including the calculation of the area of interest, the expressions, and the output processing.

The number of the program that is being executed is shown at the top right of the screen.

Each button in the main toolbar is selected by clicking on the left mouse button. Most of the buttons access a secondary toolbar and menu, the others toggle between two states. For two-state buttons, the background of the button is darker when it is pressed.

Navigating the toolbars

When a secondary toolbar is visible, all the buttons on the screen are accessible, including the main toolbar. This makes it very easy to change menus.

The button is used to close a secondary toolbar or the detailed oscilloscope trace to return to the main screen.

The button is used to return to the previous menu. It is, therefore, very easy to switch quickly between two screens, for example the details oscilloscope trace and the integration time adjustment menu.

Main toolbar

Display the menu for parameters adjustment: language, Modbus, CAN bus

Show the integration time and line rate adjustment menu

Lens calibration menu

Show the area of interest set-up menu

Show the expression set-up menu

Show the output parameters menu

Show the RUN mode display parameter menu

Record the programs in flash memory

Toggle between displaying **the whole width of the CCD** (sampling) and displaying **all the pixels of part of a CCD** line

Freeze the video acquisition to allow the image to be studied

Show the detailed oscilloscope trace

Display modes

The display mode button toggles between two display modes:

- displays the whole width of the CCD
- displays all the pixels in part of a CCD line.

Displaying the whole width of the CCD

In this mode, the image displayed shows the whole width of the line viewed by the CCD. The CIL2048 samples the pixels (not all the CCD pixels are shown) so that the 2048 pixels are reduced to an image size compatible with the monitor. Some detail may, therefore, be lost during this process.

Displaying all the pixels

In this mode, each CCD pixel represents a screen pixel. All details are, therefore, visible but the only part of the line may be displayed at a particular time.

In this mode, a part of the oscilloscope at the bottom of the screen is shown in grey and indicates which part of the video line is being displayed. This area can be dragged and dropped using the mouse, by placing the pointer on the grey area, pressing and holding the left mouse button (the pointer becomes a small hand). The grey area can now be moved using the mouse. Release the left button at the position required.

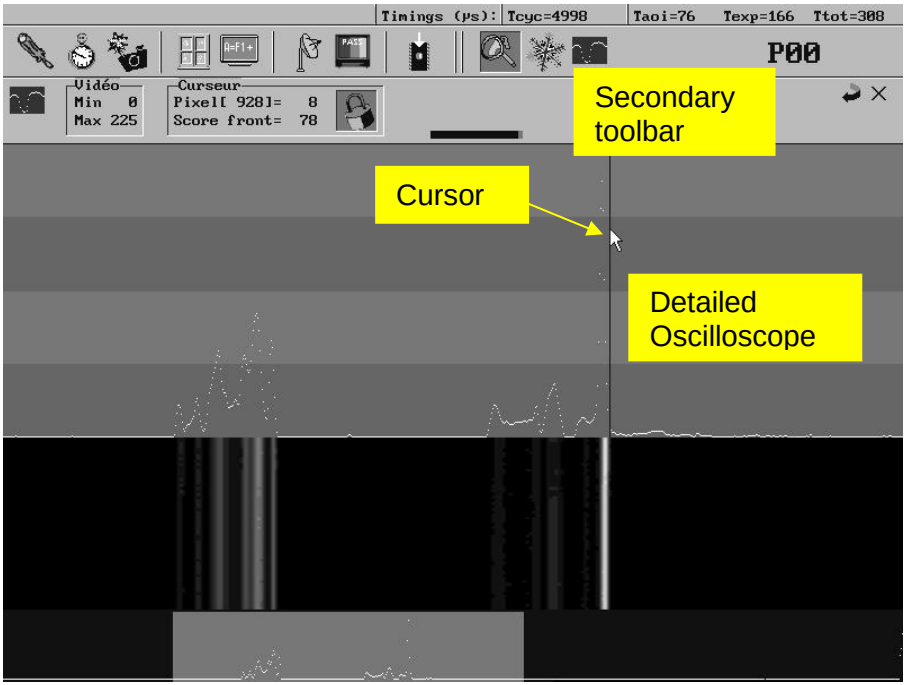
Freezing the image acquisition

The freeze image acquisition button freezes image acquisition so that the image can be studied and analysed without scrolling. Clicking again on this button unfreezes image acquisition. This button freezes all the CIL 2048 processing and is different of the display control “FREEZE” (c.f. paragraph “Display editor”)

Detailed oscilloscope trace

This display is obtained by clicking the icon

The screen copy shown hereafter presents the main toolbar and a secondary toolbar as well as an "oscilloscope" trace of the video signal, which is more detailed than that which appears at the bottom of the screen.



Secondary toolbar

The secondary toolbar in the "detailed oscilloscope trace" window has two frames Video and Cursor.

Video frame

This frame shows the minimum and maximum of the video signal. If the maximum value is 255, the signal is saturated at least on one point.

Cursor frame

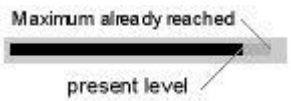
This zone gives information on the pixel which is under the black vertical bar which appears on the detailed oscilloscope. This bar can be moved with the mouse. While clicking above and by maintaining the left button left of the mouse depressed, the mouse pointer becomes a hand which allows the displacement of the cursor.

The first line of the zone has the form Pixel[number] = level of gray, and indicates the position of the pixel (number) and the level of gray of the pixel (from 0 to 255).

The second line "Edge Score" indicates the value used for the detection of transitions. The stiffer the edge is, the larger this value will be and better the edge will be detected.

The icon looking like a lock which appears in this zone makes it possible to automatically position the cursor on the point which has the best edge score in the vicinity of its original position. The cursor follows the edge then.

When this icon is activated, a bar graph indicator appears.



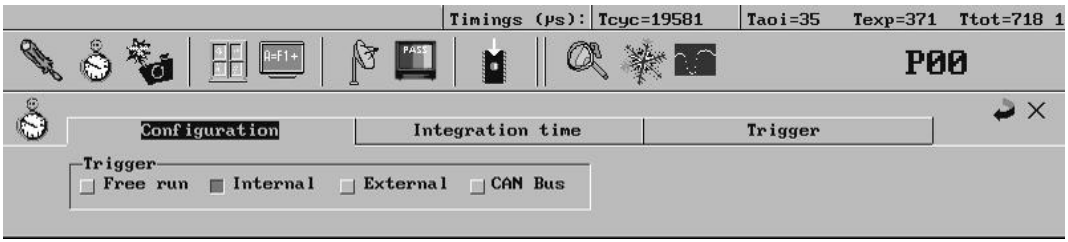
This bar graph represents the edge score and the maximum reached value. This indicator can be used to optimize the lens focusing by maximizing the edge score.

Timings editor

This editor is accessed by clicking on . It enables you to set up integration time (c.f. paragraph “Integration time”) and trigger (c.f. paragraph “Trigger”). There are several tabs :

- one configuration tab to select the trigger source
- one tab to set the integration time
- one tab to set the trigger parameters if necessary

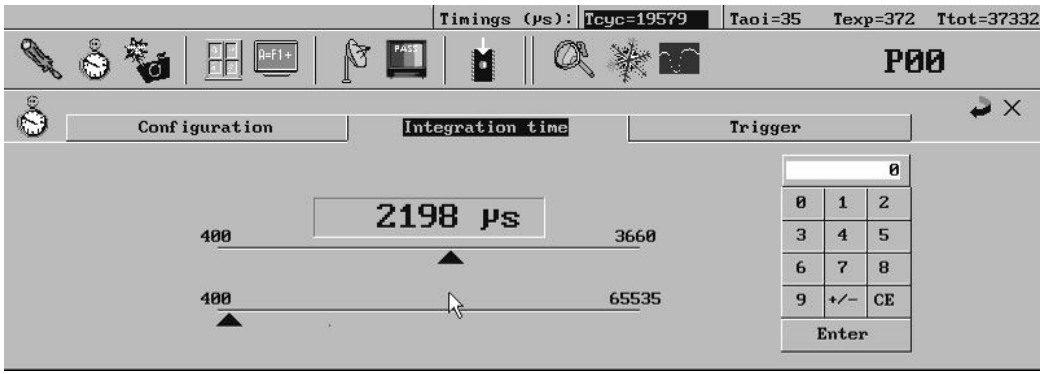
Configuration tab



The current trigger source is signalled by a depressed button. Select the desired trigger source by clicking on one of this buttons :

- "**Free run**" : the capture of a new line starts as soon as possible. This mode provides the highest line rate.
- "**Internal**" : the trigger is generated by an internal clock with an adjustable period adjustable in the "Trigger" tab.
- "**External**" : one or more inputs (INP0 to INP2) can be used to trigger the cycle on rising edges, falling edges or both. The inputs are set in t he "Trigger" tab.
- "**CAN Bus**" : an external device can trigger the cycle at the same time on all cameras connected to the bus.

Integration time tab



The current integration time is displayed in a frame at the centre of the window, expressed in microseconds.

To change it :

- drag the black triangular cursor of the upper slider for small integration times
- drag the black triangular cursor of the lower slider for large integration times
- type the desired integration time on the numeric keyboard and click on “Enter”.

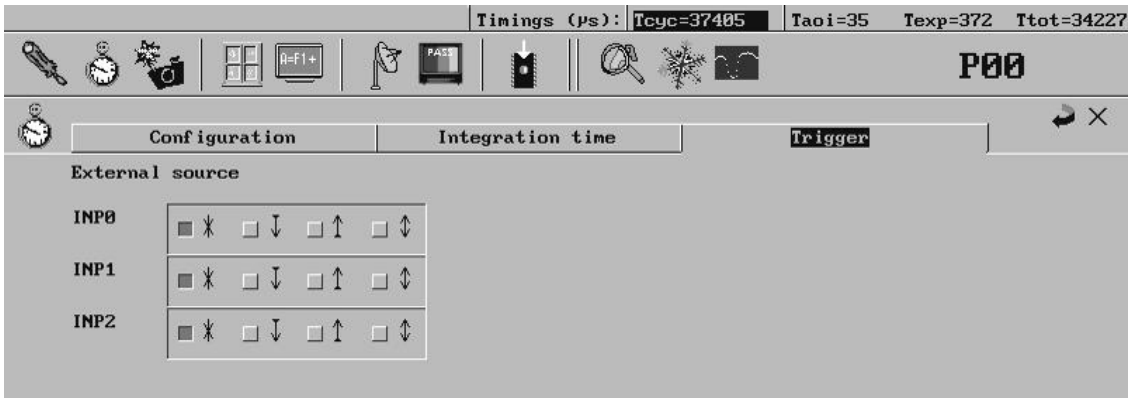
Trigger tab

The trigger tab depends on the selected trigger source. For “Free Run” and “CAN Bus”, there are no more parameters and this tab is not used.

Internal trigger

This tabs looks exactly like the one for the integration time. It makes it possible to change the period of the internal clock, expressed in microseconds.

External trigger



INP0 INP1 INP2 are the inputs of the camera. This one can be triggered on :

- a rising edge of the input
- a falling edge of the input
- both edges

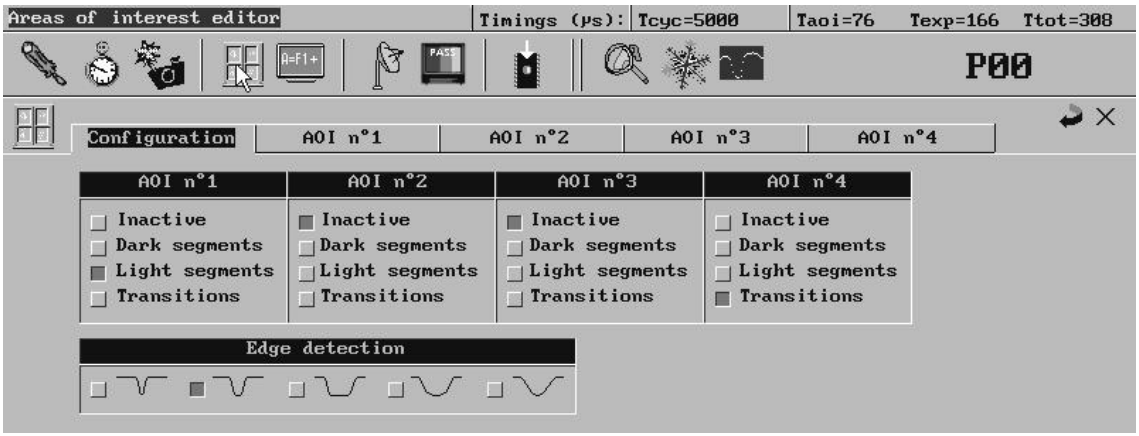
Any combinations of the 3 inputs can be specified. means that the input is not used.

Area of interest editor

This editor is accessed by clicking on . There are several tabs :

- one configuration tab to active the 4 area of interest
- one tab for each area of interest to configure its parameters

Configuration tab



Area of interest processing

The processing for each area of interest -1 to 4- can be configured in this tab according to the four following items. The selected item is indicated by a depressed square button. To change the selected item, just click on another item.

Inactive

This area of interest is not used. No CPU time is used for this area.

Dark segments

This area of interest detects dark segments (c.f. Concept of Segments). This means that it will detect black object with two ends on a white background.

Light segments

This area of interest detects light segments (c.f. Concept of Segments). This means that it will detect white object with two ends on a black background.

Transitions

This area of interest detects transitions (c.f. Concept of Transitions). This processing can be used for object with only one end in the camera field of view, or to detect the extreme transitions of transparent objects.

Edge detection

This zone makes it possible to adjust the detection parameter of transitions in the video. It is possible with this parameter to optimize the detection of the transitions according to their stiffness and to the minimal width of the segment which must be measured.

Indeed, if this parameter is too strong, the width of the narrow segments will not be measured correctly (it will be too high, however the position of the centre of the segment will be correct). Conversely, if the parameter is too low, very smooth edges will not be detected. The correctly measured minimal width is as follows:

“very narrow details”	5 pixels
“narrow details”	9 pixels
"normal"	17 pixels
"smooth edges"	33 pixels
"very smooth edges"	65 pixels

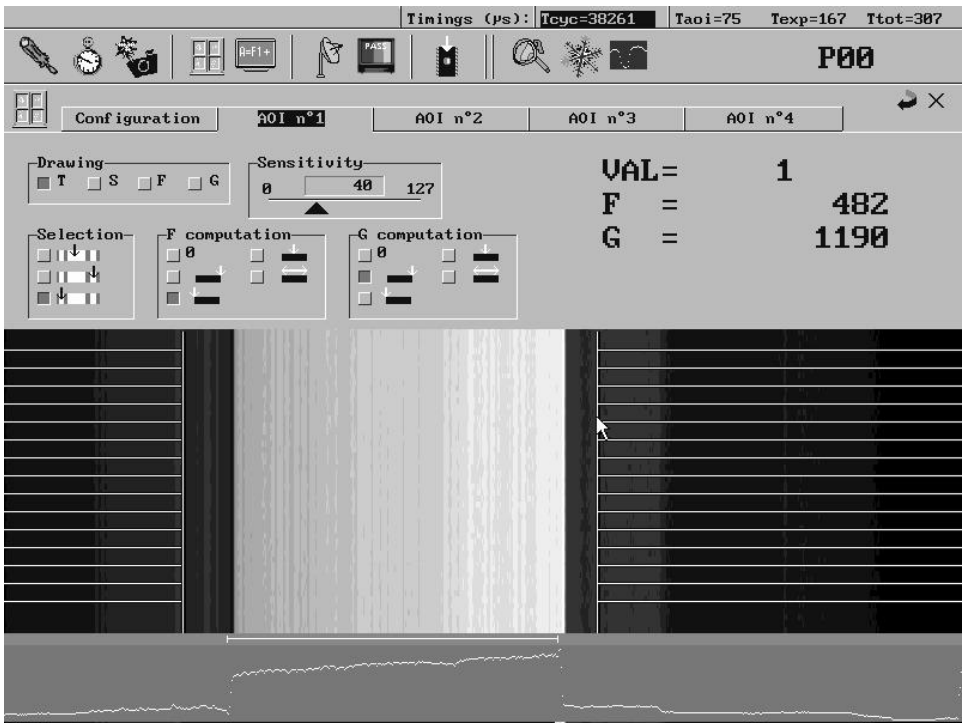
This parameter set on “smooth edges” or “very smooth edges” can also be used as a filter to suppress small segments that could be erroneously detected.

The following rules can be applied :

- The “normal” position will be adequate for most if the cases.
- If you are interested by small details on a smoothly changing background, select “narrow” or “very narrow” details.
- If you are interested by smooth edges and want to suppress small details, select “smooth edges” or “very smooth edges”.

Area of interest tab

There is one tab for each area of interest -1 to 4-.



The area of interest concept is described in the paragraph “Area of interest”. Please refer to this paragraph for detailed description.

In the left part of the tab, the VAL, F and G values are displayed in real time.

- **VAL** is a Boolean which indicates whether a segment within the AOI has been identified. If a segment could not be identified, for example there were no transitions, VAL is set to 0 and the other values remain unchanged.
- the two integers **F** and **G** are the result of a calculation on the selected segment. This calculation is set-up by using the frames of this editor.

Just over the oscilloscope trace, there is small area containing a drawing of the detected transitions or segments. This drawing is controlled by the frame “Drawing”.

AOI Position

The area of interest can be positioned by using the two “curtains” that appear on the left and on the right of the scrolling image. Click on the vertical line at the limit of the “curtain”, and drag it, holding the mouse left button down.

Transitions or segments will be detected only if they are completely included in the central zone between the two “curtains”.

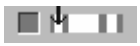
Selection

Among the segments detected in this area of interest, one, and only one, must be selected for the ongoing processes. If the area of interest is in transitions mode, a pair of transitions is selected.

The content of this frame changes according to the selected area of interest processing.

Light or dark segment

There are three choices to select the segment :

- largest segment
- rightmost segment
- leftmost segment 

The selected choice is indicated by the depressed button. To change this selection, just click on another button.

Transitions

There are two choices to select the pair of transitions :

- outer transitions of a light object
- outer transitions of a dark object

The selected choice is indicated by the depressed button. To change this selection, just click on another button.

F and G computation

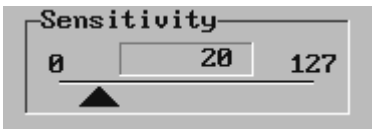
The following choices are available to calculate the **F** and **G** values using the selected segment or transitions pair :

- no value (save CPU time)
- right edge
- left edge
- centre
- width

The selected choice is indicated by the depressed button. To change this selection, just click on another button.

Sensitivity

The sensitivity is explained in the paragraph “Transition detection sensitivity”. This frame contains a slider which enables you to change the sensitivity. Just click on the black cursor and drag it holding the left mouse button down.



The current sensitivity is displayed above the cursor.

Adjust the sensitivity to obtain the desired transitions. This can be done by observing the actual transitions, but a good starting value for the sensitivity could be half the “Score front” obtained in the cursor frame of the detailed oscilloscope trace.

CAUTION: The adequate sensitivity can vary if the “Edge detection parameter” is changed.

Drawing

This frame just controls the behaviour of the transitions or segment drawing and has no effect on the results of the area of interest.

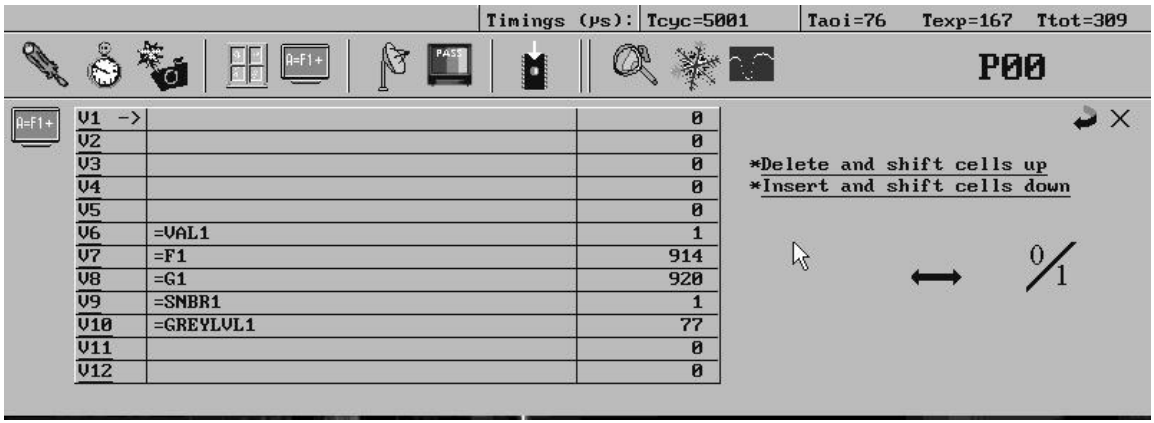
The selected choice is indicated by the depressed button. To change this selection, just click on another button. The choices are :

- T : draw all the transitions or segments
- S : draw only the selected transitions pair or segment
- F or G : draw a line at the position of the F or G value

Expressions editor

This editor is accessed by clicking on

.



This menu shows the twelve expressions named V1 to V12.

The name of the expression is displayed in the leftmost column. The central column contains the formula for the expression, or is blank for empty expressions.

The value for each expression is displayed in real time in the rightmost column.

An arrow shows the expression being edited. This one can be changed by clicking on the name of the expression in the leftmost column.

Enter a formula

If the expression has no formula, this one must be first created by clicking on .The expression now contains just the null operator "nop". A real operator must then be selected to replace “nop” by clicking on the list of operators.

The operator will appear with default parameters. Highlight the parameter to be changed by clicking on the button, then click on the desired parameter in the list. If the parameter includes an "x", a numeric value must be given. This value must be entered using the virtual numeric keyboard which appears just after having clicked on the desired operand. The value must be validated by clicking on the button “Enter”.

For example, to select the parameter F1, click on the button “Fx”, then on the key “1” of the keyboard with appears, then on “Enter” of the same keyboard.

The "(...)" item is used to insert parentheses into an expression. The parentheses are displayed with a "nop" operator inside. This is changed using the procedure described above.

The "Const x" item is used to insert a constant parameter. The cursor must be placed on the value before it is selected.

Delete an expression

To delete only the formula of an expression, select it first by clicking on its name in the leftmost column, then click the button .

To delete a line in the table and shift up the following lines, select the line by clicking on its name in the leftmost column, then click “**Delete and shift up cells**”.

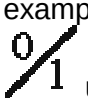
Insert an expression

To insert an expression in the table, select the line to modify and click “**Insert and shift cells down**”. The selected line and the following will be shifted down **if there is an empty line at the bottom of the table**.

Example

To enter (for instance) the following formula :

```
IF[(DeltaV1>0);IF[(F1>V4);F1;V4)];1248]
```

Select the desired line in the editor by clicking on its name **V6** for example. If the expression is not empty, delete the formula and recreate it using  until you see :

```
NOP
```

All the operators are displayed in a grid : Click on " IF "

```
IF[0;0;0]
```

Using select the first zero

```
IF[0;0;0]
```

Click on the operator (…)

```
IF[(NOP);0;0]
```

Use the horizontal arrow to blacken NOP only

```
IF[(NOP);0;0)
```

Click on the operand >

```
IF[(0>0);0;0]
```

Click on DELTAVx ; press 1 on the numeric keyboard, then " enter "

```
IF[(DELTAV1>0);0;0]
```

Using , select the second term (0) of the IF expression

```
IF[(DELTAV1>0);0;0]
```

Click on (…)

```
IF[(DELTAV1>0);(NOP);0)
```

Use the horizontal arrow to blacken NOP only

```
IF[(DELTAV1>0);(NOP);0)
```

Click on the button for the operator ”IF”

```
IF[(DELTAV1>0);(IF[0;0;0);0)
```

Use the horizontal arrow to achieve this

```
IF[(DELTAV1>0);(IF[0;0;0);0)
```

Click on (…)

```
IF[(DELTAV1>0);(IF[(NOP);0;0);0)
```

Move the horizontal arrow in order to blacken NOP

```
IF[(DELTAV1>0);(IF[(NOP);0;0);0)
```

Click on >, then fill up using horizontal arrows, Fx and Vx

```
IF[(DELTAV1>0);(IF[(F1>V4);0;0);0)
```

Use the horizontal arrows and the operators to enter the rest of the IF formula, then use again the horizontal arrows to go on the last 0

```
IF[(DELTAV1>0);(IF[(F1>V4);F1;V4);0)
```

To enter the figure 1248 click on Const x , compose the figure required then press enter.

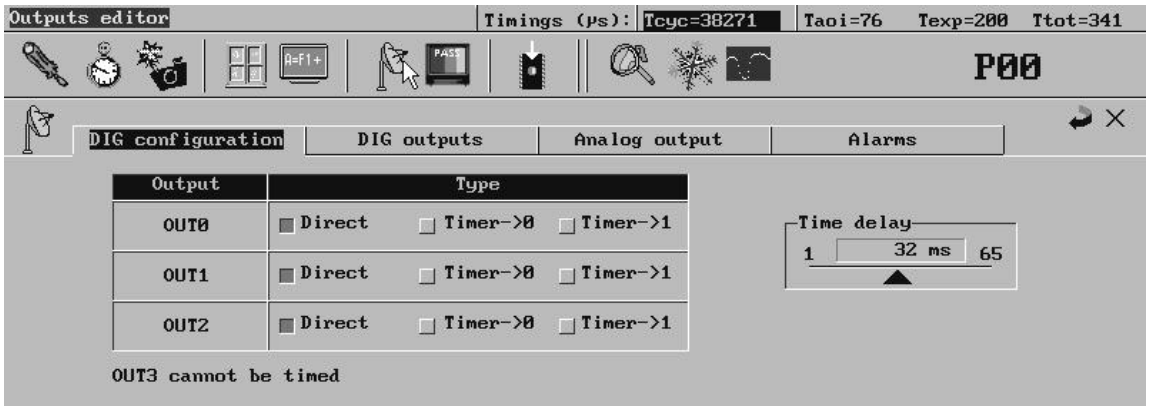
Outputs editor

This editor is accessed by clicking on . There are several tabs to configure the digital outputs, the analog output, and the alarms. The output functions are explained in the paragraph “Assignment of outputs”.

Digital outputs

Digital outputs configuration

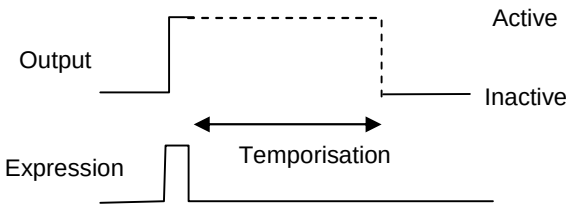
This editor makes it possible to select the configuration for the digital outputs (direct or temporised c.f. paragraph “Digital outputs”).



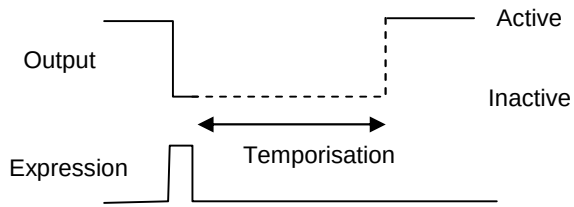
OUT0, OUT1, OUT2 are the three outputs that can be temporised.

The “Type” fields enables you to select the behaviour of the output :

- “Direct” means that the output is directly controlled by an expression’s value.
- “Timer->0” means that the output is temporised for a normally inactive output. The output is activated when the expression’s value requests it. The temporisation starts when the expression’s value changes. At the end of the temporisation after the Time Delay, the output is deactivated.

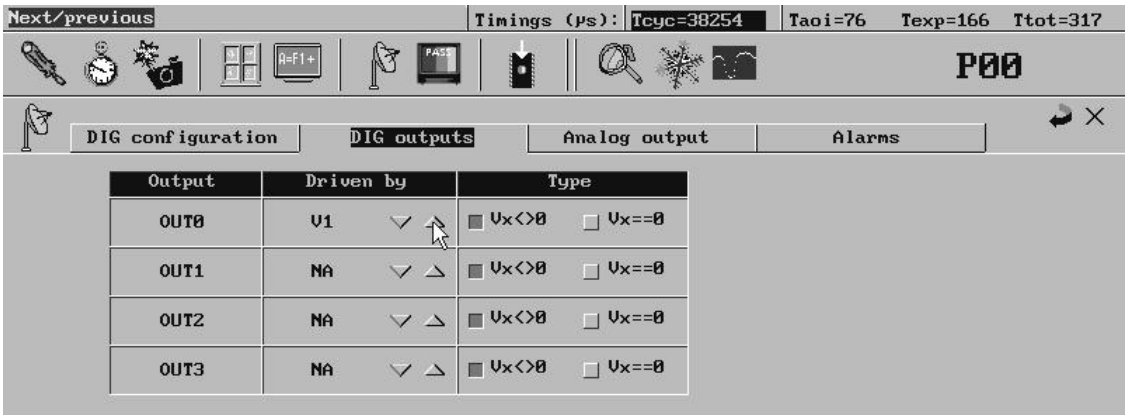


- “Timer->1” means that the output is temporised for a normally activated output. The output is deactivated when the expression’s value requests it. The temporisation starts when the expression’s value changes. At the end of the temporisation after the Time Delay, the output is activated.



To adjust the delay between 1 and 65 ms, drag the black cursor in the “Time delay” frame. The delay is the same for all the outputs.

Digital outputs control

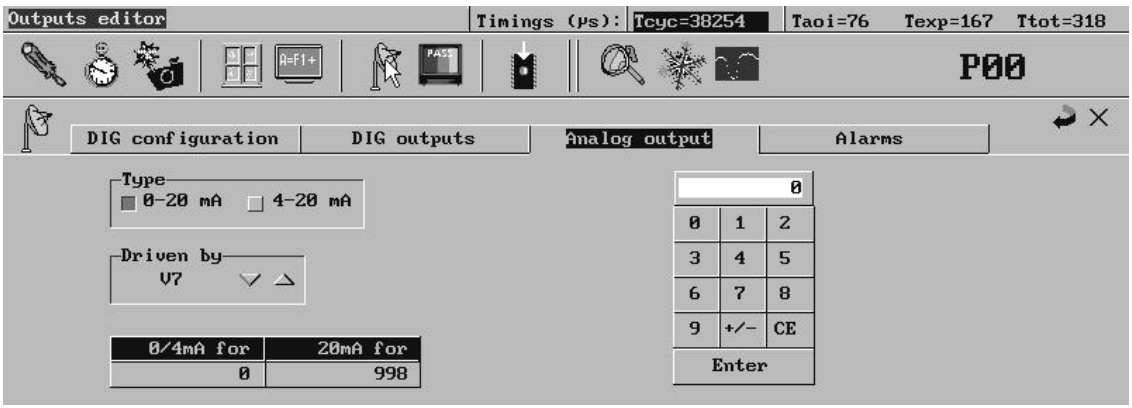


The “DIG outputs” tabs contains two fields enabling you to select the expression controlling the four digital outputs OUT0 to OUT4.

The “Driven by” column indicates which is the expression controlling the corresponding output. “NA” means that nothing is displayed. Click on the up arrow or down arrow until you obtain the desired expression.

The “Type” fields enables you to change the polarity of the output. ”Vx<>0” means that the output is active when the expression is not null, “Vx==0” when the expression is null.

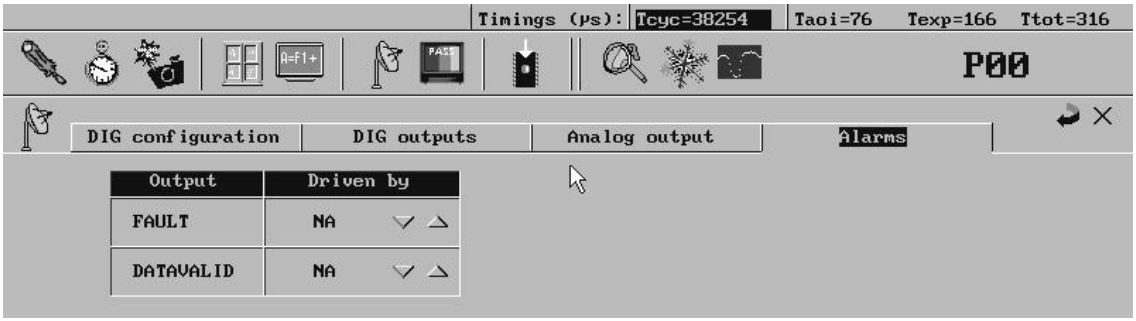
Analog output control



The type of the output can be selected in the frame “Type” : 0-20 mA or 4-20 mA. The frame “Driven by” makes it possible to select the control expression. “NA” means that the output is not used.

The field “0/4 mA for” contains the value of the expression for which the output gives the lowest current (0 or 4 mA depending on the type). The field “20 mA for” contains the value of the expression for which the output gives the highest current.

ALARM and DATAVALID control



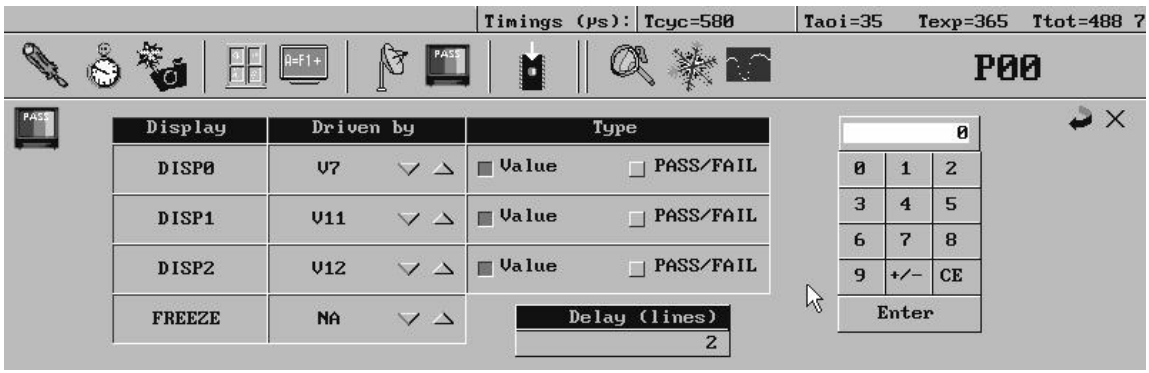
The “Alarms” tabs contains two fields enabling you to select the expression controlling the output ALARM (FAULT) and DATAVALID.

- NA means that the signal is not controlled
- Click on the up arrow or down arrow until you obtain the desired expression.

ALARM and DATAVALID are detailed in the paragraph “Alarm outputs”.

Display editor

This editor enables you to configure the RUN mode display on the monitor screen.



Display frames

DISP0, DISP1, DISP2 are the three display frames at the top of the RUN screen.

The “Driven by” column indicates which is the expression controlling the corresponding frame. “NA” means that nothing is displayed. Click on the up arrow or down arrow until you obtain the desired expression.

The “Type” fields enables you to select a value display of the expression (figure) or a “PASS/FAIL” indication.

Freeze

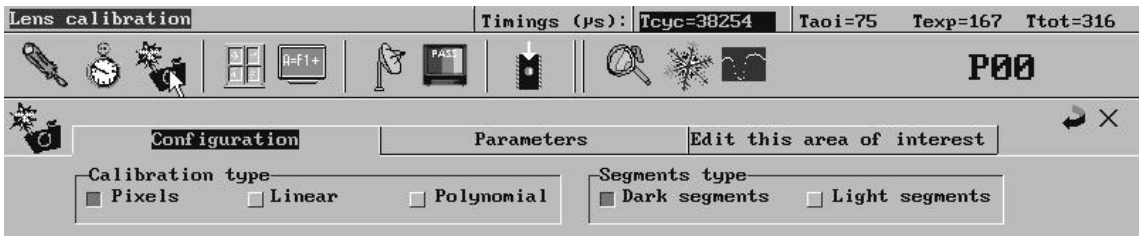
“FREEZE” enables you to freeze the grey-level scrolling image. This mode can be useful when you want to freeze a defect’s image on the screen until an operator acknowledges it. The processing itself is not frozen and defects continue to be detected.

The “FREEZE” function must be driven by an expression’s value. Click on the up arrow or down arrow until you obtain the desired expression. When the expression becomes true, the scrolling is frozen after a certain delay which is expressed in video lines number. When the expression returns to false, the normal scrolling is restored.

The delay before freezing makes it possible to have defect’s images nearly centred on the screen. To adjust its value, select the “Delay” field by clicking in it and type a value on the numeric keyboard. Click on enter when done.

Calibration

The calibration has been introduced in the paragraph “Calibration”. The calibration windows is obtained by clicking on .

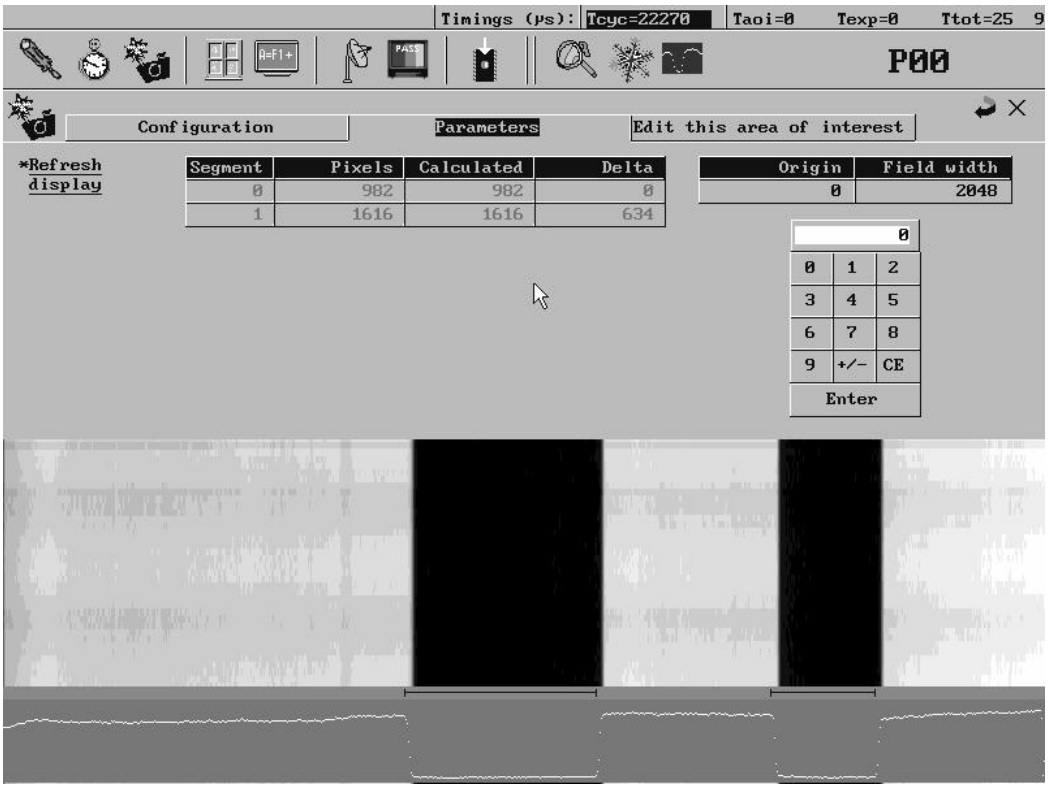


The first tab “Configuration” makes it possible to select the desired calibration type : pixels, Linear, or Polynomial. In this tab, the Segments type refer to the test pattern used to make or test calibration.

Linear calibration

If you do not need to compensate for lens distortion you can convert measurements in pixels in your favourite unit using only linear conversion.

The “Parameters” tab enables you to configure and test the calibration. For all segments of the test pattern seen by the camera, a table shows the position of the centre of the segment, in pixel and in calibrated value, and the difference with the previous segment.



It is necessary to enter the value of the total field of the camera, that is to say the width of 2048 pixels (in an unspecified unit) as well as an origin. One can place the origin

anywhere. This procedure remains manual because one can use it for other reason that pure calibration.

It is necessary to make a measurement of the total field manually: this can be done by measuring the width of an object (which thus does not cover all the field) and to make a proportion to determine the width of 2048 pixels.

To enter the origin or the field view, select the field by clicking on it. The input field appears on a reversed background. Then type the desired value on the numeric keyboard. When done, click on enter.

The “Edit this area of interest” tab makes it possible to adjust a temporary area of interest for the calibration test pattern only. The available parameters are the position of the area (curtain) and the sensitivity. Refer to the paragraph “Area of interest editor” for more information.

Polynomial calibration

Calibration pattern

You need to prepare a calibration test pattern made with typically eight black segments with dark background (or the reverse) spaced regularly so that the left edge of the first segment and the right edge of the last segment correspond to the maximum width of the field.

Place the calibration test pattern at the upper surface of the object level . The segments must be dispatched regularly so that the first and last sides correspond to the maximum position of the metal sheet when the width is maximum.

It is better to use whenever it is possible dark , thin segments.

You must measure very accurately the width of those segments and the space between them, because later on you will need to enter in the camera the absolute position of the centre of each segment.

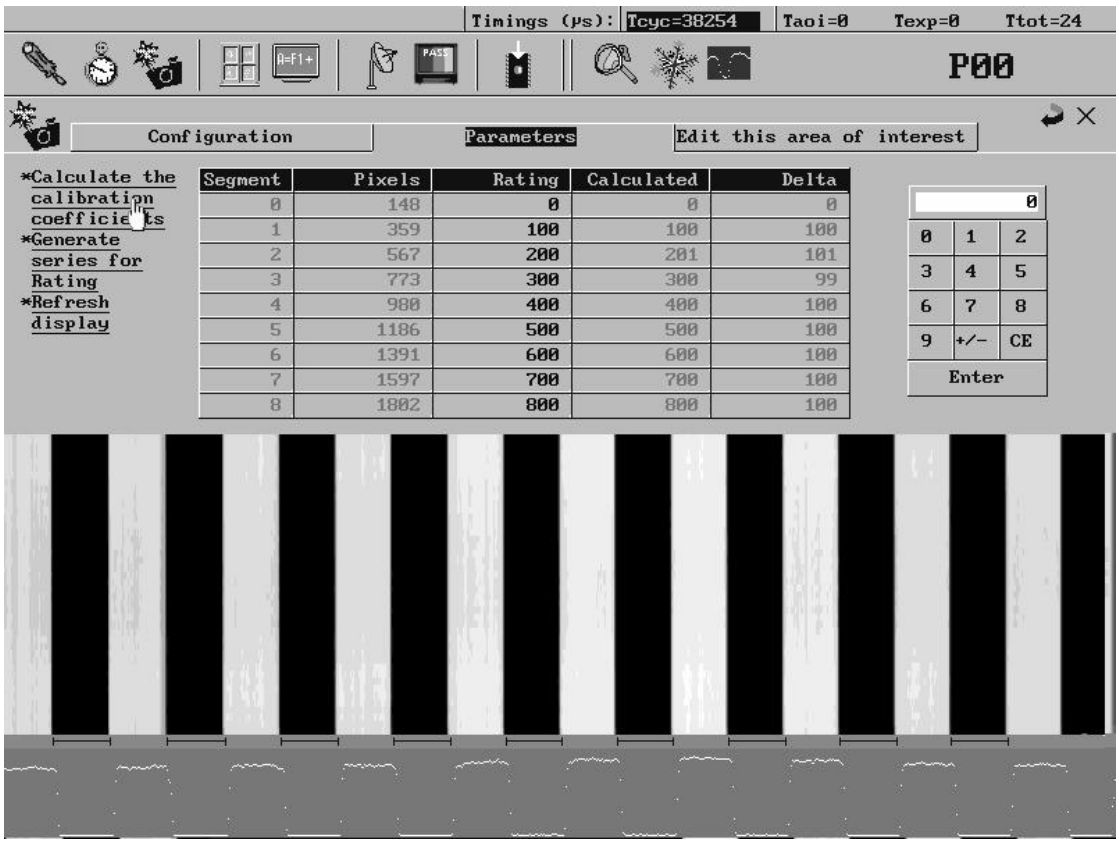
NOTE: It is not important that the segments have the same width or same spacing. But you must have a precise measurement of the segments’ centre position.

Procedure

Select the "polynomial" configuration "polynomial" and the segment type according to the calibration pattern.

In "Edit this area of interest" , adjust the area of interest size. Adjust "sensivity" so that the system correctly detects all the segments .

Go to "Parameters" tab.



The system displays for you a table giving details about the segments of the calibration test pattern.

- “Segment” means segment number (it starts at 0, so if you have nine segments it goes from segment 0 to segment 8).

- “Pixels” means the position of the centre of each segment in pixels (the origin is pixel 0)
- "Rating" is where you enter the actual /real position of the center of each segment.
- “Calculated” means the segment position calculated through the polynomial.
- “Delta” means the difference between one segment and the previous one. This eases calibration control for regularly spaced bars.

Enter directly in the required unit the centre positions. For this, select the field by clicking on it. The input field appears on a reversed background. Then type the desired value on the numeric keyboard. When done, click on enter. If you have regularly spaced segments, you just have to enter the first two segments’ centre, than click on “Generate series for rating”

When done, click on "calculate the calibration coefficients". The polynomial is calculated. Check the calibration quality with on the table.

Flashing programs

When the parameters for the different programs have been correctly set up, they are saved by clicking on the button. All the CIL 2048 programs (0 to 14) are then written in the flash memory.

Caution: Recording the program number 15 allows to reset the memory and to recover the factory configuration of the CIL 2048.

Backup and restore

CILLINK utility

CILLINK.EXE is a WIN32 utility which makes possible the communications between the CIL 2048 and a PC in order to save and restore the parameters of the application.

CILLINK doesn’t require installation. Just copy the file CILLINK.EXE to a convenient directory and double-click its icon to start the program.

The CIL 2048 must be connected to a COM port of a Windows PC -COM1 2 3 or 4- by its RS232 connector using a point-to-point direct cable. No configuration is necessary on the CIL 2048 because the communication protocol is "autobaud". When one launches CILlink.exe, it scans the available COM ports among COM1 COM2 COM3 or COM4 for the CIL 2048.

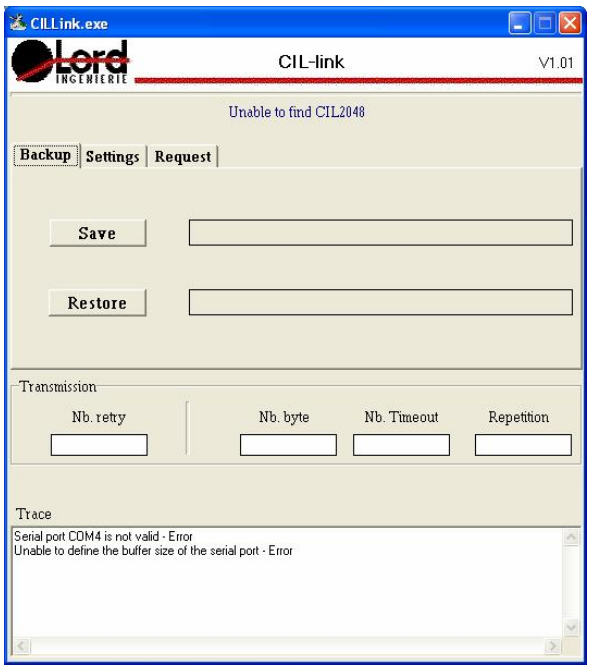
If the auto-detection fails, the "Settings" tab makes it possible to impose a COM port and a communication speed. After modification, it is necessary to click on "Accept" to validate and scan again for the CIL 2048.

The connection state is displayed at the top of the window.

Backup operations

The "Backup" tab has two buttons: Save and Restore.

- “Save” makes it possible to record in a ".CIL" file the parameters contained in the flash. Click on “Save” and give the desired file name.
- “Restore” makes it possible to restore the contents of the flash from a file. Click on “Restore” and navigate to the file containing the desired backup.



CAUTION : “Save” doesn’t save the parameters from RAM memory : in the event of a modification of the CIL 2048 configuration, it is necessary to record the programs to be able to save the modifications.

NOTE: “Restore” doesn’t modify the content of the RAM memory: it is necessary to re-start the CIL 2048 to charge the recovered parameters.

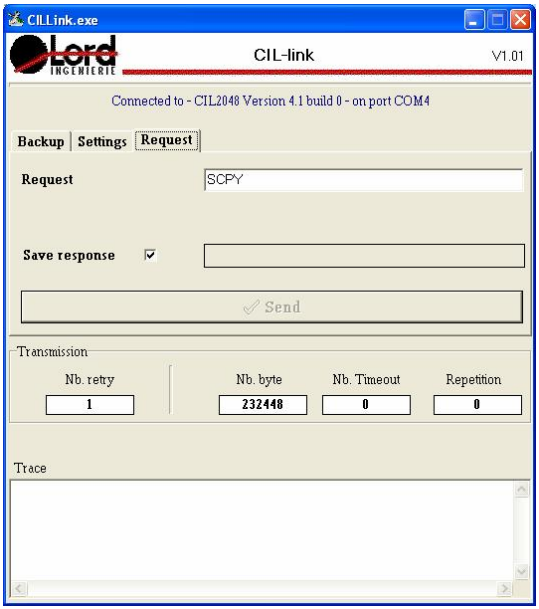
Alternate Requests

The "Request" tab makes it possible to send various requests to the CIL 2048. The request processing by the CIL 2048 can return a file which can be recorded if “Save response” is ticked.

It is necessary to type the request in the ad hoc field, and to click on "Send".

The available requests are "CLEARALL" and “SCPY”

- CLEARALL clears all parameters in the CIL 2048 and resets it to the factory default (to be used with precaution...).
- SCPY can save CIL 2048 screen copies to make procedures for example. It is necessary to tick "Save response" and to click on "Send". The name of the graphic file is then asked. As the file will be in TIFF format , it is necessary give a name with a “.TIF”.



6 Connecting the CIL 2048

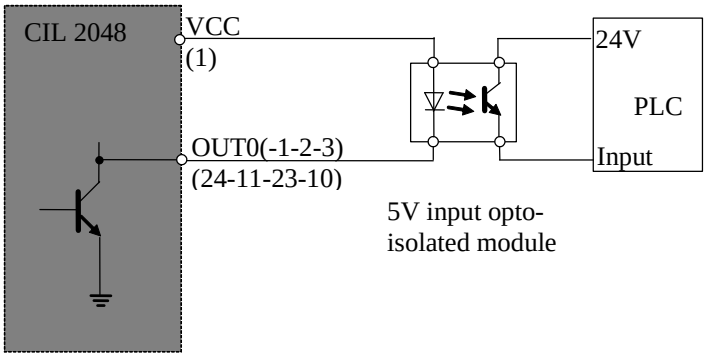
Inputs and outputs

Digital outputs

- The outputs are Normally Open: an active output is shorted to ground.
- Maximum voltage: 50 V
- Maximum sink current: 200 mA continuous, 500 mA peak.

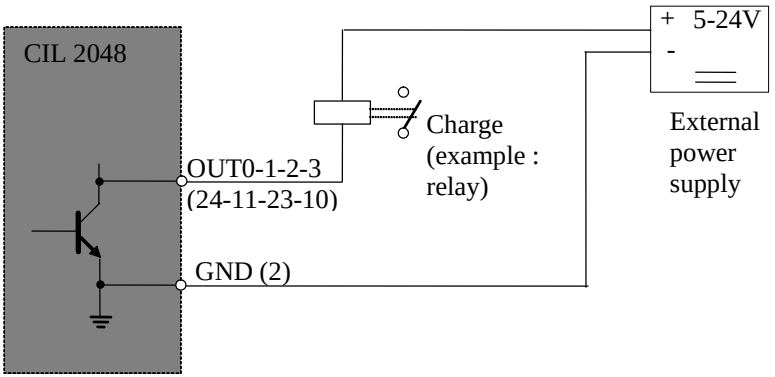
Using an opto-isolated module

This mode is the preferred method to interface industrial devices such as PLC.



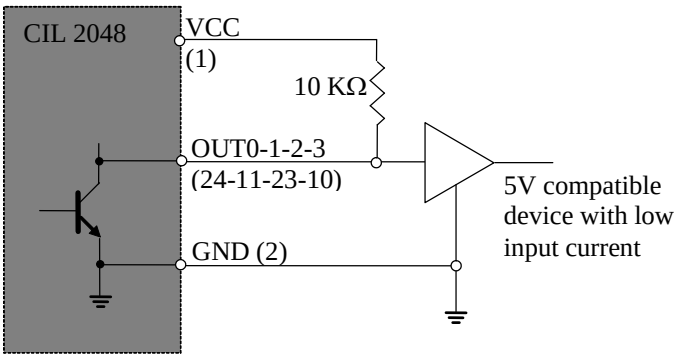
Using an external power supply

This mode is used to connect a charge with a high operating current (led, relay, 24V opto-isolator).



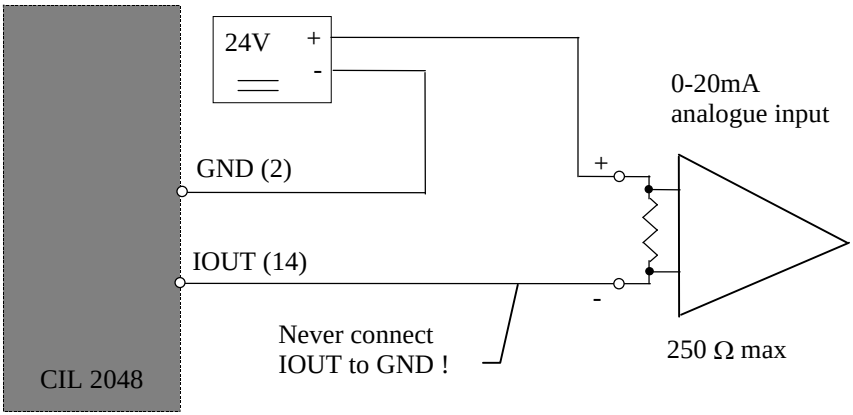
Using an external pull-up

This mode is used to connect a 5V TTL input compatible device.



Analog output

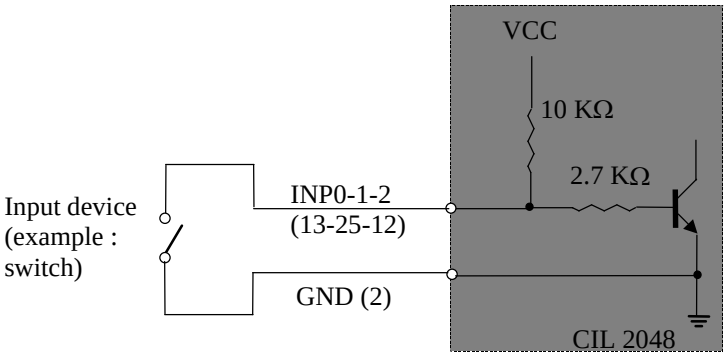
An external isolated 24V power supply is necessary, as IOUT acts as a current sink. The connected device must have a differential input with a current sensing resistance of no more than 250 Ω.



Digital inputs

The input pins INP0 INP1 INP2 must be driven to GND.

- Maximum input voltage: 30 V
- Internal pull-up : 10 KΩ



CAN bus

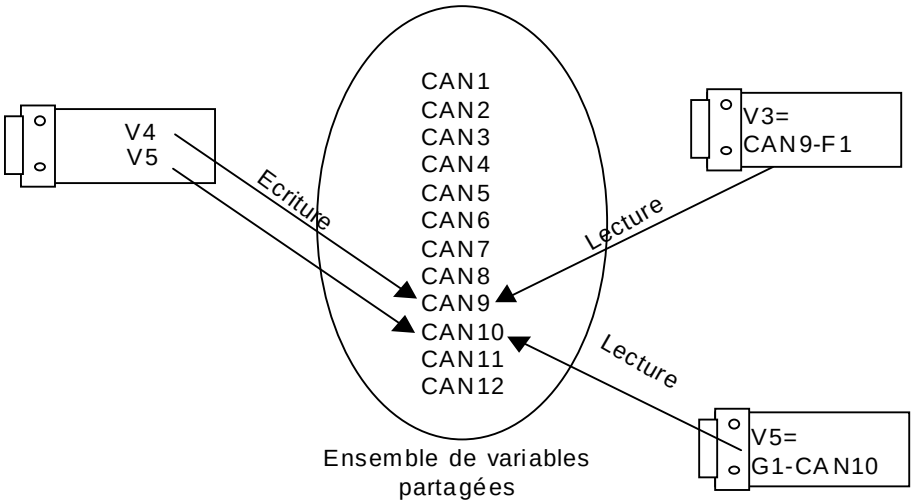
For many applications, it can be useful to connect several cameras CIL 2048 to carry out a combined measurement. For example two cameras can be used to measure with high precision the width of an object of great dimension, a camera measuring the position of the left edge and the other the position of the right edge. A camera must then retrieve the measurement of the other camera in order to make the difference of the two measurements, the exact distance separating the cameras having to be determined by calibration.

Presentation

Shared variable Principle

CIL 2048 implements a mechanism of shared variables over the CAN bus. A set of twelve shared variables, named CAN1 to CAN12, has the property to reflect automatically any modification carried out on any camera, making this modification available to all the other cameras connected to the CAN bus. The shared have then an identical value for all the cameras and can be updated and be used on different cameras.

Note : Each CIL 2048 can be configured to update two shared variables at each processed video line. On the other hand, a camera can read an unspecified number of shared variables.



CAUTION: A shared variable should be written only by only one camera. If several cameras are configured to write the same variable, its value becomes indefinite.

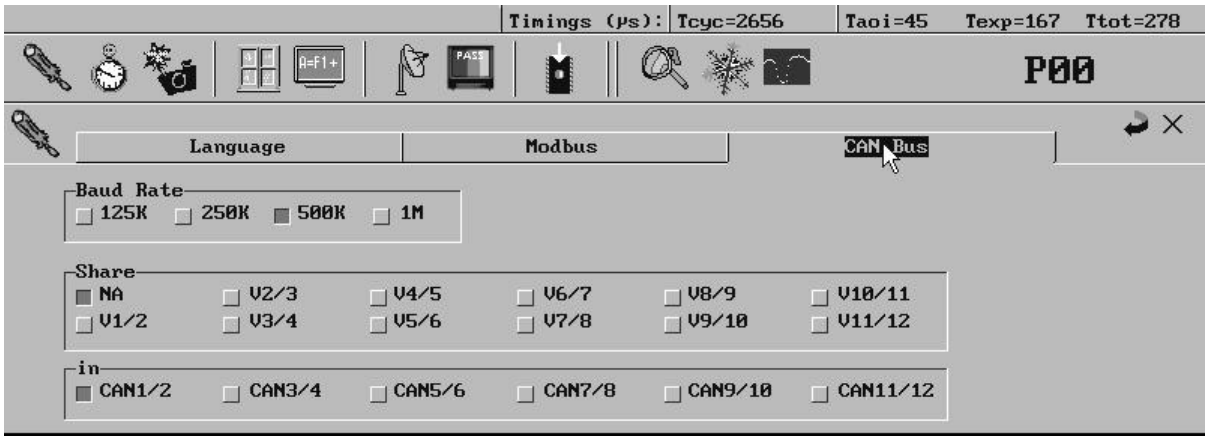
It is possible to connect one or more cameras to an external device by the CAN bus. This device, which can be a PC equipped with a CAN interface board, can then maintain a local copy of the shared variables table.

It can also trigger the cameras cycle by a special message so that integrations of the various cameras are synchronous. It is necessary for that to select CAN bus as source of the trigger in the trigger control tab (accessible by the icon).

The communication application of the external device must respect the protocol defined in the paragraph “CAN Frames definition”.

CAN Bus Parameters

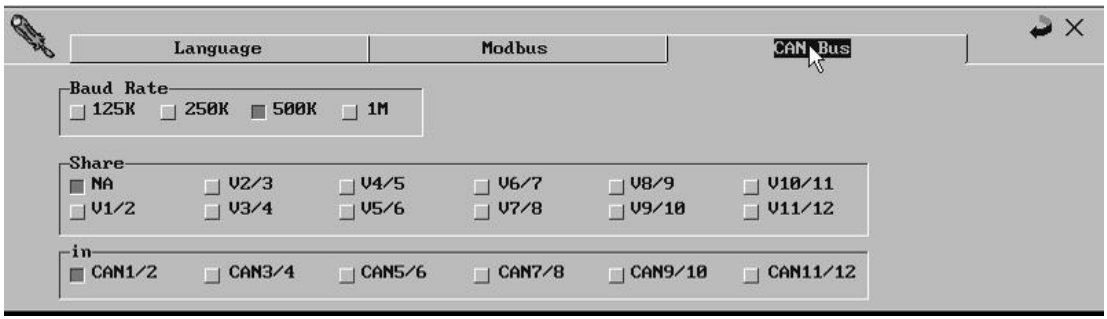
The various parameters of the CAN bus can be adjusted in the tab "CAN bus " of the "Parameters" page.



Click on the icon "Parameters" .

The available parameters are available in the tab "CAN Bus".

The configuration below indicates that the value of the V4 expression can be read by all the cameras in variable CAN9 and the value of the V5 expression can be read in CAN10.



Baud rate

The speed of the CAN bus can be adjusted to 125 kbit/s, 250 kbit/s, 500 kbit/s or 1Mbit/s. Speed must be selected according to the overall length of the bus. The following table presents the maximum lengths according to selected speed.

Bus speed (kbit/s)	Bus Maximum length (m)
1 000	30m
500	100m
250	250m
125	500m

NOTE: Speed must be identical for all the cameras connected to the bus.

Share

It is possible to select the two variables which will be transmitted to the other cameras. NA means that no variable is transmitted by this camera. V1/2 indicates that the variables V1 and V2 will be transmitted at each video line, V2/3 indicates that this is the V2 and V3 variables which will be transmitted, and so on.

In

This parameter specifies in which CAN shared variables are emitted the two data selected in the "Share" tab.

Example :

Shared variables access

The shared variables are accessible in the expressions with the operand CANx where X represents the number of the shared variable.

Communication failures

A CIL 2048 which shares two variables transmits at each cycle a message containing the value of the variables. When the CAN bus is disturbed, it is possible that the message of the previous cycle could not yet be transmitted. In this case, the CIL 2048 lengthens its cycle in order to wait until the previous message has been well transmitted. This waiting is limited to 40 milliseconds.

In cases of disturbed bus, the CIL2048 lights the led n°1.

Wiring

The CIL2048 is equipped with a CAN connector with the standard pinout CIA DS-102 (http://www.can-cia.de)

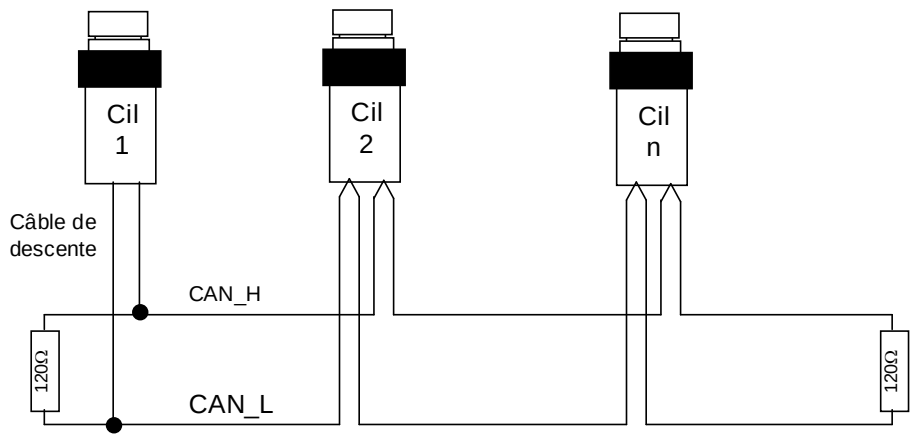
Pins 6 and 9 can be used to power the camera from an external 24V power supply. If the various cameras and devices connected to the bus have a common ground, it is not necessary to connect CAN-gnd.

1			
	6		GND
2		CAN L	
	7	CANH	
3		CAN-GND	
	8		
4			
	9		24 V
5			

CAUTION: The different grounds are connected inside the camera, and are connected to its metal case. In order to avoid any ground loop being able to induce spurious electromagnetic signals, it is highly recommended to isolate the camera from the metal mass on which it is possibly assembled.

Bus topology

The bus must be wired in linear bus topology. Terminating resistors of 120Ω are necessary at each end of the bus trunk. The star configuration is not possible. It is possible to use drop cables, but those must be shortest possible (0.3m maximum). The overall length of the bus depends on speed (see table in the paragraph "Baud rate").



Cable Specification

The cable used to wire the bus must contain two shielded twisted pairs, a pair being used for the bus signals, a pair being used for the power supply.

The pair used for the bus signals must have the following characteristics:

- charateristic impedance 120Ω
- propagation delay 5 ns/m
- DC properties DC (for no more than 32 nodes) :

bus length	Cable resistance	Cable section	Terminator resistance	Maximum speed
0 .. 40m	70 mΩ/m	0.25mm² AWG24,AWG23	124 Ω (1%)	1 Mbit/s @ 30m
40 .. 300m	<60 mΩ/m	0.34mm² AWG22	127 Ω (1%)	500 kbit/s @ 100m
300 .. 600m	<40 mΩ/m	0.5mm² AWG20	150 à 300 Ω	125 kbit/s @ 500m

The power supply pair must have a sufficient section according to the length of the bus and the number of connected cameras so that the loss of tension on line is not too important, especially when power-up (power supply of a camera 15 to 24V, consumption 300mA).

An example of cable specifically designed for the CAN bus is the cable : Belden part number 3084A or 3082A.

The bus can be wired to the cameras with connectors : Phoenix Contact part number Subcon-plus F3

Modbus®

The CIL 2048 has a RS485 serial port, available on the input/output connector, that can be used to connect one or several cameras to a multidrop mode bus. The used protocol is MODBUS®. The CIL 2048 can only use the RTU mode as part of this protocol.

The MODBUS communication protocol enables to a master (for example an automaton program o a PC) to access to the internal registers of one or several CIL2048 connected to the bus. The accessible values in these registers, in reading or in writing, are mainly the

values of the V1 to V12 expressions, with functional parameters of the camera (integration time, cycle time, sensitivities etc.).

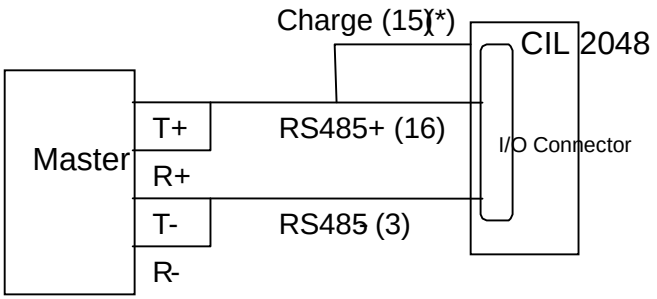
The writing of the status register enables to change program number over Modbus.

The values of the V1 to V12 expressions is coded on 32 bits. You can get access to these values by MODBUS either on 32 bits for the masters that allow the use of long integers on 32 bits, or on 16 bits for the masters that allow only the access to 16 bits registers. In this case, the value is coded in a pair of 16 bits registers, and the application must combine them before using it.

Cabling to the camera

The RS485 bus of the CIL2048 is on two wires and works in « half duplex » mode only. It is available on the I/O connector of the camera.

The connection to a COM port of a PC needs the use of a RS232 / RS485 converter.



(*) The last connected camera on the bus must carry a charge resistance with a value equal to the impedance of the used cable. In the case of the use of a 100 Ω cable, a resistance of 100 Ω internal to the CIL 2048 can be used. In that case, the 15th and 16th lead of the connector must be short-circuited.

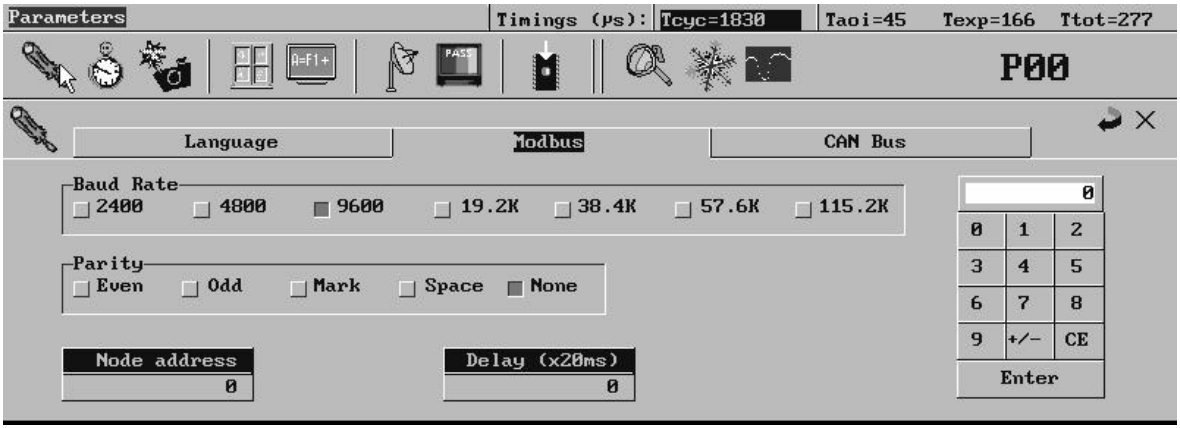
Parameters

The following parameters can be configured as per the « Parameters » menu of the CIL, « Modbus » tab :

speed : from2400 bauds to 115kbauds

parity : Even, Odd, Mark, Space, No parity

node address : from 1 to 247



NOTE : No function with an « Broadcast » address (address 0) can be used.

CAUTION : The maximum count of the data included in a frame is 251 bytes, either in receiving or in sending mode.

Data Coherence

The CIL2048 recalculating the values of the expressions V1 to V12 at each video line and the pooling of the master being done in an asynchronous way may cause data consistence problems.

When the 16 bits access to the two registers containing a 32 bits value, it is important that the most significant word and the least significant word are coherent. **For that, it is important that both registers are read within the same MODBUS request.**

The coherence between the different values V1 to V12 is only guaranteed if the reading is done by the master inside a same and unique request.

Moreover, the CIL2048 implements a lock mechanism (« latch ») for the V1 to V6 values. The writing of a « COIL » directs the transfer of the values to these locks. All required values in a query are transferred at the same time, with a guaranteed coherence. The locks can then be read with no trouble. Their value remains the same until the next transfer query.

For the use of meters, the CIL2048 implements a mechanism allowing to get back the current meter value and then put it back to nought without taking the risk of losing the meter units that could have been active while the reading and the restart. For this, the writing of another « COIL » directs the value to the lock, and then the expression back to nought. The lock can then be read at anytime while the counter is being active.

Definition of accessible objects via MODBUS

The modbus master considers the camera CIL 2048 as two register sets : a 16 bit register set and a 32 bit register set. Two « COILS » enable the use of expression locks .

Holding Register (« holding register »)

16 bit-Registers table

Register	Contents
0001	Status
0002	Integration Time
0003	Required Cycle Time in internal trigger mode
0004	Effective Cycle Time
0005	Area of interest 1 sensitivity
0006	Area of interest 2 sensitivity
0007	Area of interest 3 sensitivity
0008	Area of interest 4 sensitivity
0101	V1 HI
0102	V1 LO
0103	V2 HI
0104	V2 LO
….	…
0100 + 2*i - 1	Vi LO
0100 + 2*i	Vi HI
…	…
0123	V12 HI
0124	V12 LO
0201	Lock for V1 HI
0202	Lock for V1 LO
0203	Lock for V2 HI
0204	Lock for V2 LO
…	…
0200 + 2*i - 1	Lock for Vi LO
0200 + 2*i	Lock for Vi HI
…	…
0223	Lock for V12 HI
0224	Lock for V12 LO
0300	Transitions number for area of interest 1

Register	Contents
0301	Transitions number for video line
0302 – 0331	Transitions for area of interest 1
0332	Transitions number for area of interest 2
0333	Transitions number for video line
0334 – 0363	Transitions for area of interest 2
…	
2000-3024	Values of all the pixels

32 bit-Register table

Register	Contents
1001	V1
1002	V2
…	….
1000 + i	Vi
…	…
1012	V12
1101	Lock for V1
1102	Lock for V2
…	…
1100 + i	Lock for Vi
…	…
1112	Lock for V12

Registers Definition

0001- Status

This register consists in the following bits :

N° of bits	Meaning	Access Mode
0 (LSB)-3	Number of ongoing programs (0 to15)	Read/write
4	Ongoing mode : 0 PROG , 1 RUN	Read only
5	Freeze trigger	Read/write
8	INP0 : input state 0	Read only
9	INP1: input state 1	Read only
10	INP2: input state 2	Read only

The program number is changed to the value of the bits 0 to 3 if it does not correspond to the ongoing program.

0002- Integration Time

This register contains an unsigned 16 bits value between 400 and 65535. It indicates the integration time in microseconds. This register can either be read or written. In this case, the new integration time is applied at the next change of program.

0003- Cycle Time

This register contains an unsigned 16 bit value between 600 and65535 . It indicates the cycle time in microseconds in internal trigger mode. This register can either be read or written. In this case, the new cycle time is applied at the next change of program.

0004- Effective Cycle Time

This register contains an unsigned 16 bit value that represents the time of the last cycle measured in microseconds, whatever the trigger. This register can only be read.

010X/010X+1- Vx (16 bits) Expression value

The 16 bit-register pair 010X / 010X+1, where X is comprised between 1 and 12 corresponds to the signed 32 bits value of the Vx expression. The 010X first register contains the most significant word.

These registers can be read or written. In this last case, the expression takes the value given in the request until the CIL2048 updates again this expression's value. This is never the case if the expression's formula is empty in the CIL2048 expression table.

In order to guarantee the consistency between the two least and most significant words, accesses to both registers must be done within the same request using functions 3 or 16.

020X/020X+1- Vx (16 bits) Lock expression

The 16 bits 020X / 020X+1 registers pair, where X is comprised between 1 and 12 corresponds to the signed 32 bits of the Vx expression lock . The 010X first register contains the most significant word.

These registers can only be read. Their value is updated by a COIL writing at points 101 or 201.

*0300+(a-1)*32/0331+(a-1)*32- (16 bits) area of interest "a"*

This range of 16 bits registers contains the results for an area of interest. The first word contains the number of transitions in the area of interest, the second the total number of transitions in the video line, the following words contain the position of the transition on the 12 least significant bits, and the direction of the transition on the most significant bit. This bit is null for downwards transitions.

100X- Vx (32 bits) expression value

The 32 bits 100X register where X is 1 and 12 corresponds to the signed 32 bit value of the Vx expression. These registers can either be read or written.

110X- Vx (32 bits) expression lock

The 32 bits 110X register where X is between 1 and 12 corresponds to the signed 32 bit value of the expression lock of the Vx expression. These registers can only be read. Their value is updated by a COIL writing at points 101 or 201.

2000 – 3024 – (16 bits) values of the pixels

Values of the pixels from the CCD, packed by 2 in unsigned 16 bits registers. The first pixel is in the most significant byte.

COILS

The writing of a COIL by the function 15 (Force Multiple Coils), no matter ON or OFF, causes an operation upon the expression locks.

Coil	Contents
0101	Transfer of the V1 instantaneous value in the V1 lock
0102	Transfer of the V2 instantaneous value in the V2 lock
…	…
0100 + i	Transfer of the Vi instantaneous value in the Vi lock
…	…
0112	Transfer of the V12 instantaneous value in the V12 lock
0201	Transfer of the V1 instantaneous value in the lock and V1 reset to 0
0202	Transfer of the V2 instantaneous value in the lock and V2 reset to 0
…	…
0200+i	Transfer of the Vi instantaneous value in the lock and Vi reset to 0
…	…
0212	Transfer of the V12 instantaneous value in the lock and V12 reset to 0

7 Examples

This chapter gives some programming examples for better understanding of the use of expressions, operators, and operands.

Maximum width Measurement

This example shows how to measure the maximum width of an object seen from the top and demonstrates **how to get the maximum of a value**.

The area of interest 1 is configured to detect the object as a segment and F1 is set-up as the width of the largest segment.

V1	**IF[VAL1;F1;0]**	If there is a segment, V1 is equal to the width of that segment, else 0
V2	**=SNBR1**	number of segments in the area of interest
V3	**IF[(V3<V1);V1;(IF[(DELTAV2<0);0;V3])]**	V3 is the maximum local width ; V3 resets when a new object appears

V1 is necessary because if there is no segment, F1 keeps the last segment's value. A new object's beginning could be missed by V3 if the new width is smaller than the previous maximum.

VAL1 is true when one or more segment exists.

DELTAV2 = $V2_{previous\ line} - V2_{current\ line.}$ Therefore DELTAV2 is negative when a new object is starting. DELTAV2 is positive when an object is ending.

Length measurement

This example shows how to measure the length of an object and demonstrates **how to memorize values**.

The length is measured in term of number of video lines. Knowing the speed of the product and the cycle period, one can easily compute the length in metric unity.

No F and G are required, but the area of interest 1 must be configured to correctly detect a segment representing the object.

V1	**=VAL1**	true if there a segment.
V2	**IF[(DELTAV1<0);LCNT;V2]**	If a new object appears V2 is assigned to the video line number. Else it keeps its previous value (memorization)
V3	**IF[(DELTAV1>0);(LCNT-V2);V3]**	If the object disappears, V3 is assigned to the current line number minus V2, i.e. the length, and memorized.

When an object appears, the video line number is memorized in V2. At the end of the object this value is substracted from the current line number in V3. Therefore V3 the object length (in terms of number of video lines).

DELTAV1 = $V1_{previous\ line} - V1_{current\ line.}$ Therefore DELTAV1 is negative when a new object is starting. DELTAV1 is positive when an object is ending.

Simultaneous measurement of length and width

The area of interest 1 is configured to correctly detect a segment representing the object. F1 is set to measure the width of the segment.

V1	**=VAL1**	true if a segment exists
V2	**IF[(DELTAV1>0];V3;V2]**	will memorize the value of V3 (length in terms of lines) at the end of the object
V3	**IF[VAL1;(V3+1);0]**	Counts the video line number

		(length) when there is a segment. Resets when no object is present.
V4	**IF[(DELTAV1>0);(IF[(F1>=V4);F1;V4]);0]**	Memorize the maximum value of width between two object endings

This program is based on the expression evaluation order. The counting cell V3 counts the video lines when an object is present but resets at the end of the object. As V2 is calculated before V3, it can memorize the last value of V3 just before it resets.

« Surface » measurement (summing the segments widths of an object)

The area of interest 1 is configured to correctly detect a segment representing the object. F1 is set to measure the width of the segment.

V1	**IF[VAL1;V2;V1]**	Memorizes the previous value of V2.
V2	**IF[VAL1;(V1+F1);0]**	Calculates the surface by adding all segments lengths. Resets when there is no object.

An equivalent expression for V2 is:

```
ACCU[VAL1;F1;(NOT VAL1)]
```

Detecting and counting objects

This example demonstrates **how to use inputs**.

The area of interest 1 is configured to correctly detect a segment representing the object.

V1	**=VAL1**	V1 is true (1) if object exists
V2	**ACCU[(DELTAV1<0);1;(NOT INP0)]**	Every time a new segment is detected, the counter is incremented ; counter is reset upon external signal

Detecting a local defect

It is difficult to find local defects on an edge with a non constant position. FILTER enables you to have a value following the slow variations of the edge, but not the local quick variation.

The area of interest 1 is configured to correctly detect a segment representing the object. F1 is set to measure the edge position of the object.

V1	**FILTER[F1;600]**	Low passed filtered edge position * 1000
V2	**CHECK[F1;(V1/1000);10]**	Check the non filtered value against the filtered one with a tolerance of 10 units.

8 Maintenance

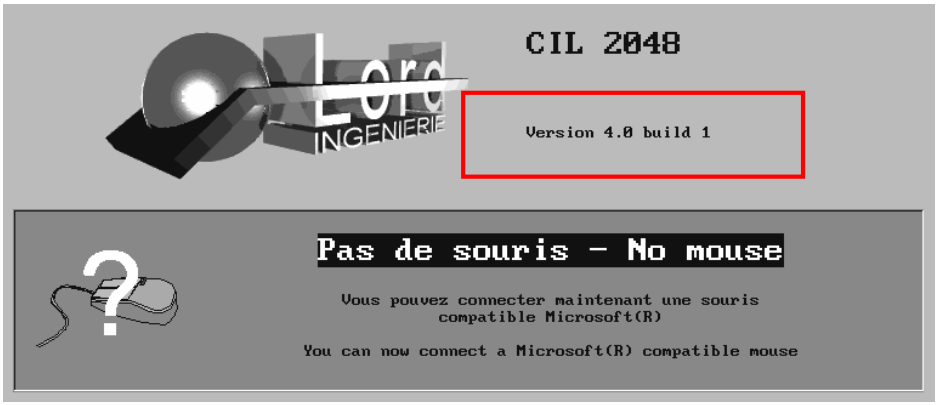
Firmware

Identifying the firmware version

Connect the monitor, or the CILBOX to the CIL 2048 with the cable "CBL/CIL/XXX".

Do not connect the mouse, and switch on the power supply. Turn the switch (monitor's front panel) to enter the programming mode "PROG".

A screen with an error message is displayed. The firmware version is posted just over this message. It is outlined in red in the following screen copy.


CIL 2048
Version 4.0 build 1
Pas de souris - No mouse
Vous pouvez connecter maintenant une souris compatible Microsoft(R)
You can now connect a Microsoft(R) compatible mouse

Updating the firmware

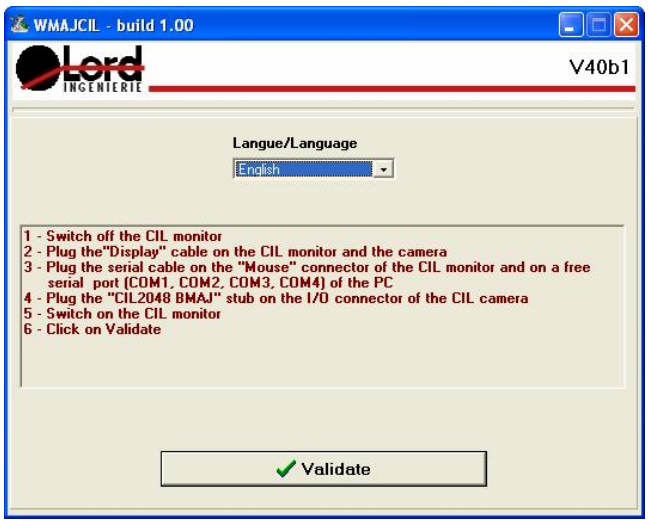
To update the firmware of a CIL 2048 camera, you will need :

- a PC · with a serial port -COM1 to COM4-. USB serial port are supported.
- the CIL 2048 monitor with its cable "CBL/CIL/XXX"

- a null-modem serial cable - female/female -
- a stub connector "CIL2048 BMAJ" (SUB-D 25 points female connector with the following straps : 1 -17 , 2-8-9-21-22)
- an updater file, delivered in the form of an auto-extractible file.

Procedure

1. Copy the updater file on the PC in a temporary directory such as C:\temp and execute it by clicking twice on the file's icon. Select the desired language.


WMAJCIL - build 1.00
Lord INGENIERIE
V40b1
Langue/Language
English
1 - Switch off the CIL monitor
2 - Plug the"Display" cable on the CIL monitor and the camera
3 - Plug the serial cable on the "Mouse" connector of the CIL monitor and on a free serial port (COM1, COM2, COM3, COM4) of the PC
4 - Plug the "CIL2048 BMAJ" stub on the I/O connector of the CIL camera
5 - Switch on the CIL monitor
6 - Click on Validate
Validate

2. Put the switch of the CIL 2048 monitor in position OFF and shut down the power supply of the camera if it is external
3. Connect the cable "CBL/CIL/XXX" between the monitor and the camera.
4. Connect the serial cable between the connector "Mouse" of the monitor and a serial port (COM1, COM2, COM3 or COM4) available on the PC
5. Connect the stub connector "CIL2048 BMAJ" on the I/O connector I/O of the CIL 2048 camera.
6. Switch on the CIL 2048 monitor or the camera's power supply if external
7. Click on the button "Validate" on the updater's window, then the CIL 2048 being detected, click on "Update" and wait for the end of the operation. Check the result of the update in the lower frame.

Parameters

The working parameters are recovered and translated from older versions up to version 2.6 build 0. However, it is recommended to check the parameters after update.

Update reversion

The update of the firmware does not modify the parameters recorded in the flash as long as one does not click on the icon . It is thus possible to update a camera which contains an application, to test it with the new version, then to return to the previous version without having to enter again the application. On the other hand, as soon as one clicks on , returning to the previous version re-initializes parameters to factory default values.

Of course, one must have an updater file for the original version.

Failure diagnostics

This paragraph list some common failures and give some hints to fix them, with links to the content of this manual.

The area of interest detects no transitions

This is usually caused by weak edges in the image.

- Check the position of the area of interest (c.f. paragraph “Position” and “AOI Position”). A segment will not be detected if only one of its ends is in the area.
- Check the image sharpness. Ensure that the focus of the lens, the aperture and integration time are adequate.
- Check the transition detection parameter (c.f. paragraph “Edge detection”). If your image has smooth edges, use a higher value for this parameter.
- Check the sensitivity (c.f. paragraph “Transition detection sensitivity” and “Sensitivity”). Lower it if necessary.

The area of interest detects too much transitions

This is usually caused by a textured background on the object, or dust on the lighting.

- Check the sensitivity (c.f. paragraph “Transition detection sensitivity” and “Sensitivity”). Increase it if necessary.

- Check the transition detection parameter (c.f. paragraph “Edge detection”). A higher value for this parameter can filter out small details.
- For some special applications, some tricks can be carefully tested. To suppress a texture in the background, you can try to de-focus slightly the lens in order to have a less sharp image. You can also try to increase the lens aperture or the integration time in order to saturate certain parts of the image.

The effective cycle time is too long

The expression table may be too complex. Try to simplify it.

Another cause could be a CAN bus failure. If variables are shared by a camera, but there is no other camera to acknowledge the CAN message, the cycle time is lengthened to wait the acknowledge. Check if the led n° 1 is on.

In this case, check the CAN bus, or set the camera to not share any variable.

The executed program is 15, whatever the inputs

If nothing is wired on the program number input, this means that the power supply voltage is too low. It should never be less than 14V.

If the program number inputs are used, check the wiring.

The programming interface is very slow

This can happen in “Free Run” triggering when the processing time is longer than the integration time. There is no CPU time left for the programming interface.

The trick is to use internal trigger during programming. Switch to this mode and set a long cycle period, as 10 milliseconds. When the application is done, switch back to the free run mode.

9 Technical specifications

This chapter give reference technical information about the CIL 2048.

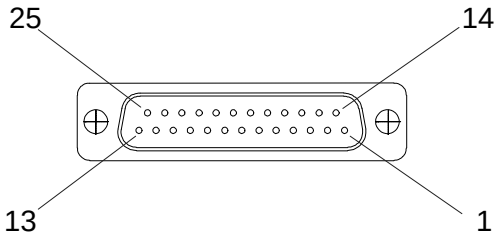
- pinout for the connectors
- Indicator leds signification
- Camera's specifications
- Modbus protocol details
- CAN bus frame definitions

Pinouts

The available connectors on the CIL 2048 are :

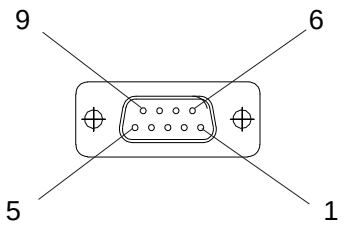
- I/O connector
- CAN connector
- Monitor connector

I/O connector



1		Vcc		5 V
	14	Iout	O	0-20 mA analogue output
2		GND		
	15	100 ohm load		connect to RS485 bus + on last unit
3		RS 485 -	I/O	RS485 bus -
	16	RS485 +	I/O	RS485 bus +
4		GND		
	17	Reserved		
5		CINT	O	Integration in progress
	18	CINT*	O	/Integration in progress
6		VALID	O	Measurement Valid
	19	ALARM	O	Alarm
7		GND		
	20	STROBE	I	Do not use in V1.4 b2
8		NPROG bit 3	I	Program number
	21	NPROG bit 2	I	-ditto-
9		NPROG bit 1	I	-ditto-
	22	NPROG bit 0	I	-ditto-
10		OUT 3	O	Output bit 3
	23	OUT 2	O	Output bit 2
11		OUT 1	O	Output bit 1
	24	OUT 0	O	Output bit 0
12		INP 2	I	Input bit 2
	25	INP 1	I	Input bit 1
13		INP 0	I	Input bit 0

CAN connector



1		
	6	GND
2		CAN -
	7	CAN+
3		GND
	8	
4		
	9	24 V
5		

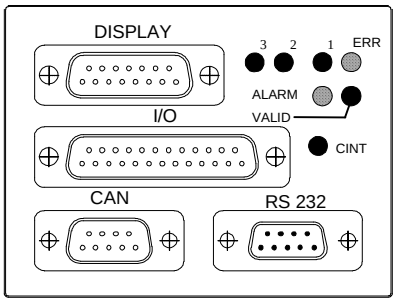
Monitor connector

1	KEY signal
2	mouse TX
3	GND
4	mouse RX
5	mouse RTS
6	GND
7	Video OUT
8	GND
9	line sync
10	24VDC
1	24VDC
12	frame sync
13	nc
14	nc
15	GND

Direct connection of a VGA device

You have have to wire the video out (pin 7) to the R, G and B inputs of the VGA connector (pins 1 , 2 ,3) with 75 ohm coaxial cable, the line sync (pin 9) to the pin 13 of the VGA connector and the frame sync (pin 12) to the pin 14 of the VGA connector. The GND from pins 6 8 and 15 should be wired to the pins 6 7 8 and 10 of the VGA connector. The power supply 24V can be fed through the CAN (DB9 connector).

Indicator LEDs



CINT This LED is lit while the light is being integrated on the CCD. The LED may flash or be dimly lit depending on the integration time and the video line rate. If the LED is not lit, the CCD is not capturing a video line.

ALARM This LED indicates the state of the "ALARM" output signal. It is lit when the alarm is active. The alarm signal can be programmed using the outputs editor management menu

VALID This LED indicates the state of the "VALID" output signal. It is lit when the measurement is valid. The measurement valid signal can be programmed using the outputs management menu

ERR This led is lit when the specified cycle time (internal trigger) cannot be respected because of the duration of the integration time or of the processing.

1 This led is lit when the CAN bus is disturbed by electric parasites or a wiring failure. This is systematic when there is only one CIL on the bus.

2 This led is lit when no valid program could be found in the flash memory. It indicates that the flash was corrupted , erased, or never programmed. The CIL 2048 should then be reprogrammed.

3 This led is not significant for normal use.

Specifications

Physical characteristics / camera

CCD sensor	2048 pixels (14x14 µm)
photosensitive area	28,7 mm x 14 mm
pixel frequency	5 Mhz
measurement rate	depends on the processing required, up to 1 700 lines processed per second for a basic operation
microprocessor	Motorola 68331 / 21 Mhz
memory	256Ko Ram, 512Ko EEPROM flash
firmware	downloadable into flash memory for update
real time system	based on µC/OS, “The Real-Time Kernel”
power supply	either through the monitor or by 24V typical (15 to 24V acceptable)
power consumption	300mA at 24V
fixing	possible on all four sides by four M4 screws, positioning by guide pins and reference surface
lens	for 24 x 36 lenses with NIKON mounting
weight	1200g
storage temperature	-30°C to +80°C
operating temperature	0°C to +50°C

Physical characteristics / development kit

video resolution	800 x 600, 256 grey levels for video, 16 for graphic overlay
vert. frequency	70 Hz
power supply	110-220 VAC
Monitor size	height 227 mm, width 251 mm, depth 322 mm

Processing functions

- four independent and superimposable processing windows, selecting four areas of interest from the 2048 pixels of the video signal
- 15 segments processed by window : search for first, last, n^{th}, largest or smallest segment, dark or bright...

- two result functions by window : width, position of the centre or of the limits of a segment, number of segments...
- elaboration of a measurement or of a decision based on logical, arithmetic or test operations comparing the results processed from the different windows with the set parameters
- transfer of information to the environment via the input/output interfaces

Electrical interfaces

- interface with monitor for development purposes
- RS232 interface, max 115 kbauds for program save and restore
- RS485 bus interface, max 1 Mbaud , for Modbus communication
- 13 bit, 0-20 mA analogue output port
- CAN field bus at up to 1 Mbaud
- three digital inputs
- four digital outputs, open collector
- four inputs, for program selection

Modbus protocol details

Supported Functions

List of the supported function codes

03	Read Holding Register	Reading of the camera registers
06	Preset Single Register	Writing of a 16 bit register
15	Force Multiple Coils	Locks update
16	Preset Multiple Registers	Writing of several 16 or 32 bit registers

Details of functions

03 – Read Holding Registers

Reading of the camera 16 or 32 bit register value.

Query

The query specifies the number and the number of registers to read. The registers can be 16 or 32 bits. The register 0001 is meant as 0.

Reading of the 002 register of the slave 10.

Field name	Example(Hex)
Slave Address	0A
Function code	03
Starting Address HI	00
Starting Address LO	01
Number of registers HI	00
Number of registers LO	01
CRC	----

Answer

The answer contains the required register value.

Field name	Example(Hex)

Slave Address	0A
Function code	03
Byte count	04
Data HI	00
Data	01
Data	5A
Data LO	43
CRC	----

06 – Preset Single Register

Writes a 16 bit register of the camera.

Query

The query specifies the number of 16 bit register to write. The 01 register is addressed as 0.

Writing of the 002 regsiter of the slave 10 with the value 1234.

Field name	**Example(Hex)**
Slave Address	0A
Function code	06
Register Address HI	00
Register Address LO	01
Preset data HI	04
Preset data LO	D2
CRC	----

Answer

The answer is an echo of the query.

Field name	Example(Hex)
Slave Address	0A
Function code	06
Register Address HI	00
Register Address LO	01
Preset data HI	04
Preset data LO	D2
CRC	----

15 – Force Multiple Coils

Writing of several COILS.

Query

The query specifies a sequence of COILS to write. The COIL 0001 is addressed as 0. The value of the forcing of each COIL is indifferent.

Field name	Example(Hex)
Slave Address	0A
Function code	0F
Coil Address HI	03
Coil Address LO	E9
Quantity of coils HI	00
Quantity of coils LO	02
Byte count	08
Force data HI	00
Force data LO	00
CRC	----

Answer

The answer indicates the number of written COILS.

Field name	Example(Hex)
Slave Address	0A
Function code	0F

Coil Address HI	03
Coil Address LO	E9
Quantity of coils HI	00
Quantity of coils LO	02
CRC	----

16 – Preset Multiple Registers

Writing of several 16 or 32 bit registers.

Query

The query specifies a sequence of 16 or 32 bit registers to write. The 0001 register is meant as 0.

Writing of 32 bit registers 1002 and 1003 of slave 10 with values 1 and 2.

Field name	**Example(Hex)**
Slave Address	0A
Function code	10
Starting Address HI	03
Startting Address LO	E9
Number of registers HI	00
Number of registers LO	02
Byte count	08
Preset data HI	00
Preset data	00
Preset data	00
Preset data LO	01
Preset data HI	00
Preset data	00
Preset data	00
Preset data LO	02
CRC	----

Answer

The answer indicates the numbers of written registers.

Field name	Example(Hex)
Slave Address	0A
Function code	10
Starting Address HI	03
Starting Address LO	E9
Number of Registers HI	00
Number of Registers LO	02
CRC	----

Exception answers

The CIL2048 may return the master an answer of exception in the case that a query would have been correctly received, but not studied.

Definition

The returned function code has then its MSB to 1.

Field name	***Example(Hex)***
Slave Address	0A
Function code	90
Exception code	02
CRC	----

Exception Codes

Code	Name	Meaning
01	ILLEGAL FUNCTION	The received function code in the query is not legal.
02	ILLEGAL DATA ADDRESS	The received address in the query cannot be used with the CIL2048.
03	ILLEGAL DATA VALUE	A received value in this data field of the query is not valid.

CAN Frames definition

The frame emitted on the CAN bus is composed of two bytes for header and 0 to 8 bytes of data. The CIL2048 protocol distinguishes two types of messages:

messages transmitted by the cameras which share variables.

message to trigger all the cameras connected to the bus.

Message transmitted by a camera

A camera which shares two expressions will transmit at the end of the processing of each video line a message composed of two bytes for header and 8 bytes of data. If the camera shares its values in CANx and CAN(x+1), the message is defined in the following way:

ID Byte1 = 0x80+n

ID Byte2 = 8

n	x	
0	1	CAN1/2
1	3	CAN3/4
2	5	CAN5/6
3	7	CAN7/8
4	9	CAN9/10
5	11	CAN11/12

Byte	**Bit**							
	7	6	5	4	3	2	1	0
ID Byte1	**ID.10**	**ID.9**	**ID.8**	**ID.7**	**ID.6**	**ID.5**	**ID.4**	**ID.3**
	1	0	0	0	n			
ID Byte2	**ID.2**	**ID.1**	**ID.0**	**RTR**	**DLC.3**	**DLC.2**	**DLC.1**	**DLC.0**
	0	0	0	0	1	0	0	0
Data Byte1	CANx –b3 – most significant byte							
Data Byte2	CANx – b2							
Data Byte3	CANx – b1							

Data Byte4	CANx – b0 – least significant byte
Data Byte5	CAN(x+1) –b3 – most significant byte
Data Byte6	CAN(x+1) – b2
Data Byte7	CAN(x+1) – b1
Data Byte8	CAN(x+1) – b0 – least significant byte

Message to trigger the cameras

An external device connected to the CAN bus, a such PC, will be able to trigger in a synchronized way all the cameras connected to the CAN bus by transmitting the following message, only composed of the two bytes of headers:

ID Byte1=1

ID Byte2=0

Byte	**Bit**							
	7	6	5	4	3	2	1	0
ID Byte1	**ID.10**	**ID.9**	**ID.8**	**ID.7**	**ID.6**	**ID.5**	**ID.4**	**ID.3**
	0	0	0	0	0	0	0	1
ID Byte2	**ID.2**	**ID.1**	**ID.0**	**RTR**	**DLC.3**	**DLC.2**	**DLC.1**	**DLC.0**
	0	0	0	0	0	0	0	0